Communications

January 1978

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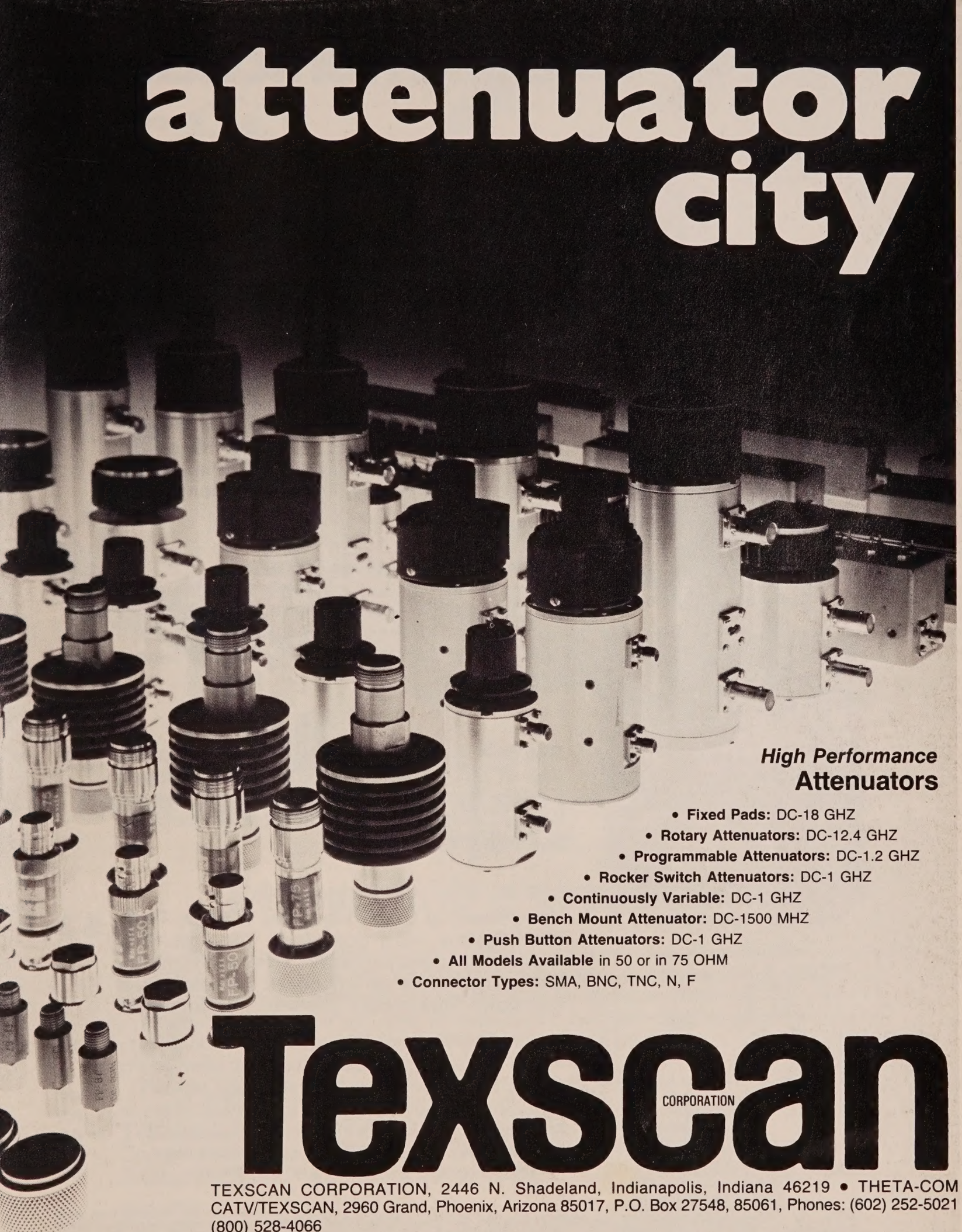
INFO/CARD 1

attenuator city



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INFO/CARD 2

Communications

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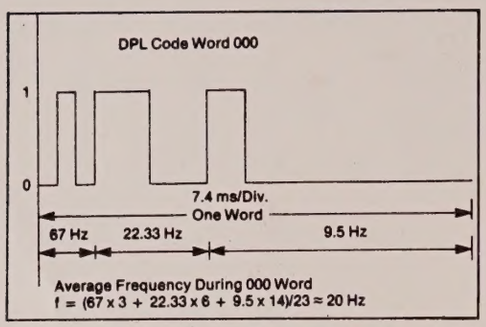

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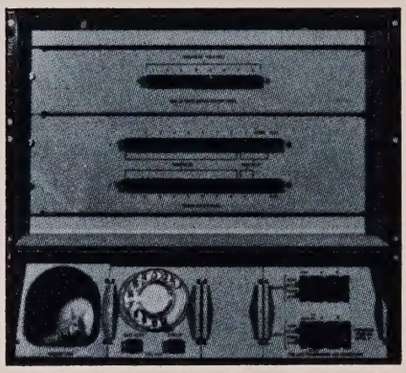

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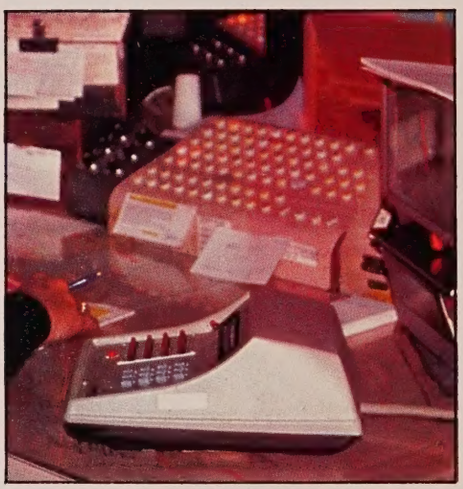

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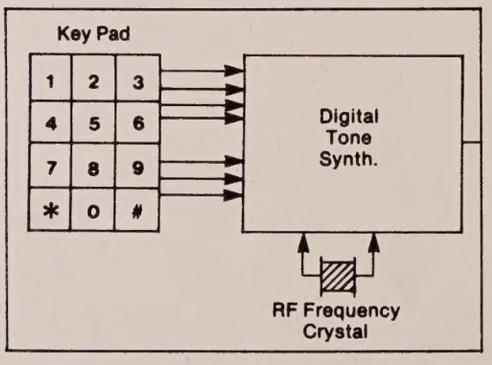

Review of DTMF Signaling p. 52

January Cover. One of the four radiopaging antennas at Central Station "looks" out over London. St. Paul's Cathedral and London Bridge are visible at the top right of the photo. **1**

An Overview of Signaling Techniques in Two-Way Radio and Paging. A complete discussion of the entire area of signaling, this article presents a comprehensive look at the various types of signaling and their applications. **18**

The Post Office Radiopaging Service. The Post Office of the United Kingdom has designed and installed a unique radiopaging system for the city of London. The system uses Zone Transmitter Controllers to provide a highly flexible operation. **32**

DTMF in the Fire Service. A unique application of DTMF signaling has been developed by the Palo Alto, California Public Service Safety Communications Division for the city's fire departments. **42**

Understanding DTMF Signaling: A Basic Technical Review. How does Dual Tone Multiple Frequency signaling work? How are frequencies used? How do encoders and decoders function? This article provides the answers. **52**

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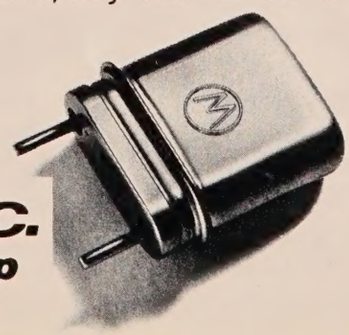

INFO/CARD 3

MOTOROLA INC.
Communications Group

*If a crystal should happen to go off frequency we'll fix or replace it upon receipt at Motorola

Letters

Radio Service Shops

Some years ago, in May 1970, your magazine published a story on radio service shops, using as an example a nationwide service company named Syntonic Technology.

As I am interested in reading more on their organizational structure, can you advise if this company still exists and if so, where their headquarters are located?

P. Lamarche
Regional Manager
Canadian National Telecomm.
Montreal, Quebec
Canada

The 65 Syntonic Technology shops are now owned by Control Data, P.O. Box O, Minneapolis, Minn. 55440. — Editor.

Congratulations And Thanks

Congratulations on a fine magazine. Your Technical Refresher Course is an invaluable asset to our business training.

I understand that in your March 1977 issue, there was an article on Civil Defense Radio. Unfortunately my subscription did not begin until August of this year.

Since most of our business is in the public safety field, I feel that this article would interest me. Would it be possible to obtain a copy of this article?

Thank you and congratulations once more for a fine publication.

Mike Osborn
Owner
Osborn Communication Service
Canton, Miss. 39046

A copy is on its way. — Editor.

The overall graphics, format and content of your October issue was "excellent". Your organization has a unique talent for selecting the type of articles that will provide meaningful information to your readers.

Indeed, your readership is numerous, because we were overwhelmed with both telephone calls and letters about our article on "Marketing Wide Area Paging Services."

Congratulations and thanks.

James J. Santiago
President
TeleCommunications Marketing
New York, N.Y. 10017

A Consultant Writes

I recently had an opportunity to glance at a copy of your magazine, *Communications,* and was very much impressed with its quality.

Would it be possible to be placed on your mailing list?

I provide consultation on emergency medical services to many ambulance, police, fire/rescue organizations. I believe *Communications* could be a great help.

John Nihart
Consultant
State of Minnesota
Department of Health
Rochester, Minn. 55901

Refresher Course

It is very refreshing and satisfying to read the "Refresher Course" articles that have been appearing in *Communications* magazine.

Many of us involved in communications service work have a tendency of falling into so-called short cut habits. Sometimes these short cut habits tend to short change the radio user in the quality of service he should expect. These "Refresher Course" articles help to keep us on the right road to proper servicing of equipment. Please keep these articles coming in future editions.

Chet Kalis
Communications Supervisor
Bay State Gas Co.
Springfield, Mass. 01101

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Correspondence concerning land mobile radio and private microwave subjects is welcomed by *Communications.* Send letters to Managing Editor, *Communications,* 1900 West Yale Ave., Englewood, Colo. 80110. The publication reserves the right to edit letters for space reasons. Telephone calls concerning matters of interest to the land mobile radio community also are invited. Dial (303) 761-3770 for assistance.

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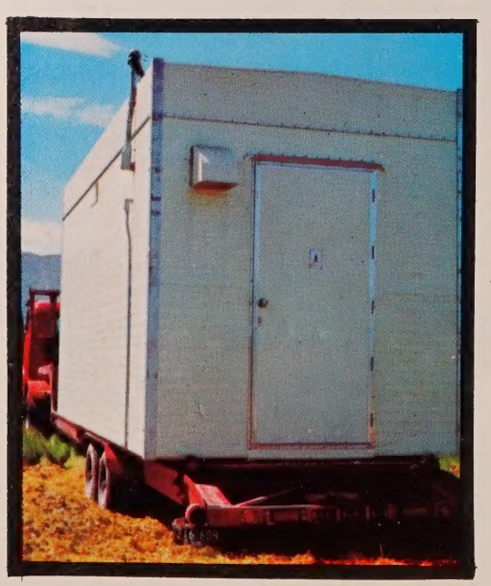
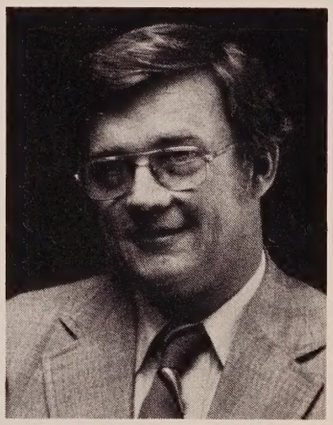


INFO/CARD 5

Mountain Parks Where There Are No Mountains

Frequency spectrum is just like real estate. There is only so much of it. The public good must be considered, particularly when things get crowded.

It would not be in the public interest, for example, for the federal government to require every state in the union to have 40 percent of all state parks for water recreation; 20 percent open land picnicking; and 40 percent for mountain parks. This is obviously ridiculous because some states don't have any mountains and some don't have enough water. The setting aside of resources for public use is great, but how it's used ought to be determined by the situation on the *regional* level.



This is also true when it comes to the frequency resource in the UHF region. As everyone in land mobile knows, the FCC is presently disposed to present a position to the WARC '79 saying that the UHF broadcasting interest should get exclusive frequency allocations without regard to local or regional situations. Whatever WARC adopts will become everyone's model.

If nothing changes in 1978 regarding the FCC position, the U.S. delegation to WARC will favor UHF-TV interests over those of land mobile radio in your community without ever knowing your town's name much less anything about its communications problems.

An eleven-year-old in a grammar school here in Denver, Colorado, recently told me how easy it was to win an election in his school. This young man was something of an expert because he was the campaign manager for a victorious class president. He said the secret was simply this: "You get everybody on your side by going around and talking to all the people who have a lot of friends and who control a lot of votes."

It seems pretty simple, doesn't it? But it sure is good advice for us in the land mobile business who have just lost an important battle in shaping the FCC's WARC '79 UHF frequency allocation position. With two new commissioners at the FCC, 1978 might be time enough to get things turned around.

Take a tip from an eleven-year-old campaign manager — get out and talk to the people who control the votes, because it is very important to the future growth and economic health of our industry that a regionally flexible approach be adopted by the FCC and presented at WARC '79. Let's not let the government legislate that we build mountain parks where there are no mountains.

Pat Wiesner
Editor and Publisher

e.r.p.
effective radiated power
The end product of Sinclair Antenna and Filter Research volume 1 number 3

8-inch Res-Lok* Introduced!

Comshel – the mountaintop communications shelter

Experienced communications people involved in forestry, logging and park management know that while mountaintops make an excellent site for a mobile radio repeater station and antennas, they are superb only as long as the equipment can withstand the thick ice and high winds which frequently bring the entire antenna system crashing to the ground.

The remoteness of these areas and the topography involved often dictate conditions that expose repeater and antenna sites to winds in excess of 150 miles per hour with a corresponding radial ice buildup that causes excessive stresses and strongly detracts from antenna efficiency. A large, easily erected, permanent fiberglass shelter to house the repeater equipment, power source and the entire antenna system was developed by Sinclair Radio Laboratories. This unit, the Comshel, had to withstand all the violent forces of nature that lurk at the top of the most challenging mountains, whether a single station or a communications network of repeater locations.

Comshel's sectionalized shelter construction is particularly suited for remote installation with limited access by truck or helicopter. The enclosure, when utilized with a reliable repeater station, conventional antennas, duplexers and a power source such as air-depolarized batteries can operate unattended for years, providing maximum protection to antennas and equipment with minimum environmental impact. The protective enclosure allows the user to install lower-cost antennas designed for less stringent environments, without having the antennas' efficiency being impaired by ice buildup. The rugged design insulates equipment from the hazards of low temperatures.

No maintenance needed

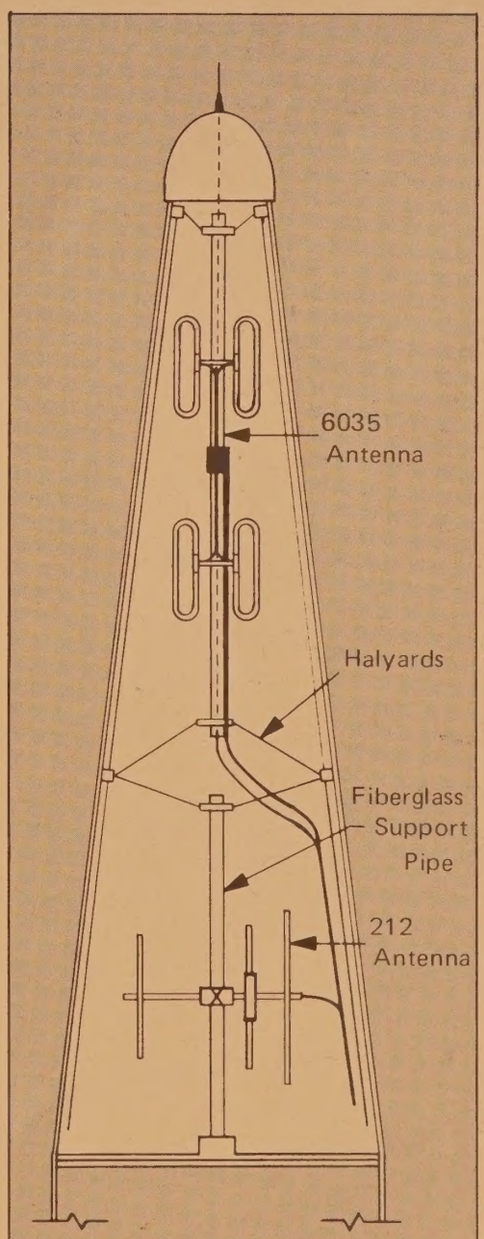
Comshel has been utilized by the Forest Service, Department of Highways, logging associations, oil firms, telephone companies and police in Canada, the U.S. and foreign countries.

The standard unit is forest green to absorb sunlight and melt any accumulation of frost, and blend into the surroundings. The surface is extremely smooth and, because of a light built-in flexing action in high winds, ice normally will not adhere to the surface. In addition to the obvious advantages for mountaintop installations, this type of enclosure can be used to provide protection from other types of environmental extremes such as sandstorms and tropical temperatures.

The unit's sectionalized construction allows it to be shipped from the factory disassembled and nested together to form the smallest possible package. Its dimensions are such that the complete package will fit inside one container. On arrival, the Comshel can be assembled completely or in parts for transportation by helicopter to truck to the final site. The basic configuration of seven-foot diameter is available in standard 15- and 28-foot heights. Different height requirements can be obtained by modifications to one or more of the modular sections. One international application required "that a Comshel unit be expanded to 36 feet in height to withstand winds of 150 miles per hour with six inches of radial ice."

In addition to its main protective function, the cone-like structure is more appealing from an aesthetic standpoint than the normal unsightly antenna "farm".

One application required high visibility and international yellow was used. The pigmented gel-coat has molded-in color



ANTENNA INSTALLATION

and provided impact, abrasion, weather and wear resistance.

The basic composition is fiberglass roving, with cloth and mat as reinforcement for a thermoset polyester resin. Depending on requirements, the basic configuration can utilize resins that contain fire-retardant additives and/or ultra-violet inhibitors. This type of construction provides high strength through excellent flexural impact and tensile properties coupled with light weight and dimensional stability.

Polyurethane insulates

The base section is composed of a reinforced laminate structure that includes a layer of polyurethane foam sandwiched between layers of fiberglass cloth and mat, impregnated with a thermoset resin. In addition to providing excellent thermal insulation for the equipment inside the shelter, the dedecahedron (12-sided) cellular characteristics of the polyurethane foam provide good strength along all axes. Polyurethane foam is three times more efficient than glass bat insulation.

The fiberglass cloth construction is similar to that used for bulletproof vests. This characteristic, coupled with the curved surface, offers improved resistance to damage caused by wind blown debris or a vandal's bullets.

On-site installation is simple and secure. The base forms an equilateral triangle on which the unit is securely fastened and guyed. Optionally available rock anchors and cables must be installed at each apex of the triangle to anchor the assembly firmly in place. Such installations have survived for years in difficult environments.

Antenna installation

The installation of antennas in the chamber above the radio equipment room is relatively easy. The top Sinclair 6035 antenna is pulled up as far as possible in the shelter by halyards. A fiberglass support pipe mounts on the top of the lower room ceiling with its upper end being secured by halyards. The SRL 212 antenna is secured to the support pipe with a No. 10 clamp. Finally, the last section of the radio equipment room ceiling is set in place. The antenna configurations are, of course, dependent upon individual requirements.

Security is maintained by the use of stainless steel hex head bolts which fasten the door to the structure, barring entry to the curious.

Sinclair Radio Laboratories not only supplies the Comshel itself, but can provide engineering assistance in selection of proper antennas and duplexers for the special requirements of mountaintop radio repeater station sites.

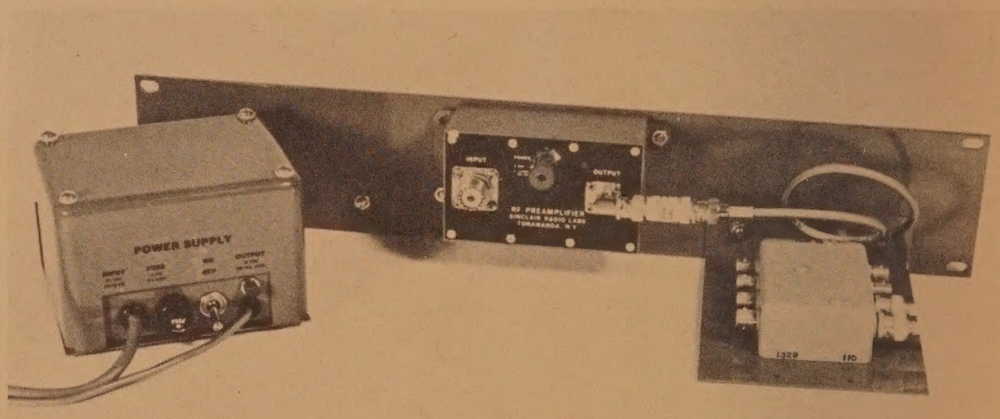
Receiver multicouplers improved

Sinclair Radio Laboratories has introduced an improved FET Amplifier which is used in the entire 30-960 Mhz SRL Receiver Multicoupler product line. Advantages of the improved amplifier are low intermodulation, narrow bandwidth and increased system sensitivity.

With the availability of good antenna sites rapidly declining, the conservation of valuable antenna space is becoming more important. Multicoupling is no longer looked upon as a convenience but a necessity. Existing sites, tending to be complex, are not always easily reoriented to compare with the efficiency of a preplanned system. However, in almost all cases, equipment may be regrouped to free valuable antenna space. The receiver multicoupler is a valuable tool in achieving this goal. The FET models are the latest generation of Sinclair receiver multicouplers which offer added reliability, greater system flexibility and low cost.

The basic multicoupler consists of an amplifier, hybrid power divider, and, when required, an attenuator for improved matching of the amplifier output to the input of the hybrid. All amplifiers have an internal gain control to adjust for optimum balance of sensitivity versus interference.

Dual gate type FET's with internal back-to-back diodes are now being used to eliminate special handling previously necessary to prevent damage from static charge build-up when replacing an FET. Reverse voltage protection is provided, along with a zener diode on the + 12 VDC input which clips voltage transients in excess of + 18



FET Solid State Receiver Multicoupler

VDC. Back-to-back silicon diodes are also provided on the amplifier input to protect against the possibility of damage due to high RF overload. They will withstand power levels of up to 5 watts without harm to the system. However, normal operation is not intended during overload, as the insertion loss is in excess of 25 dB when the diodes are conducting. Corrective action must be taken to reduce RF overload, and when the overload is removed, the system will perform normally. The I.M. performance, for the signal levels referenced on the specification, is not affected by these diodes.

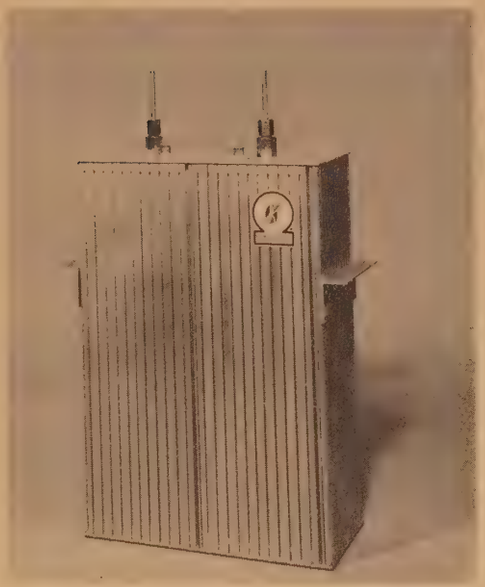
Unused terminals should be terminated in 50 ohms to maintain the specified gain/bandwidth response, though the 2-3 dB variation in the passband which may result from open ports directly at the hybrid will not render the system inoperable. Extension cables from a hybrid should never be left open circuited, as an adverse length could reflect a short circuit condition at the hybrid port and cause gain and isolation inbalance in the remaining receiver ports. This is a primary consideration when using the accessory terminal strips.

Most multicoupler models are field tunable with no special test equipment required. The 806-960 Mhz models are factory tuned for best noise figure rather than maximum gain.

The narrow band widths of our new amplifiers act as preselectors and, in many applications, eliminate the need for a separate preselector. Additional preselection is required when I.M. products are expected or high level desensing signals are present.

The FET Receiver Multicoupler normally operate from a + 12-16 VDC source. Power supply options are available for 115 VAC and 230 VAC. Positive ground option is available. Full details are available in brochure form.

Sinclair introduces 8-inch Res-Lok*



Since the first Res-Lok introduction, considerable research has been performed in system design using 8-inch Res-Lok cavities and, as with the 4-inch, the actual performance is excellent. Many models are now in service and performing even better than our earlier expectation and, in most instances, measurably better than our actual design specifications.

Our primary objective, that of physical space reduction for equivalent selectivity has been achieved. Though the 8-inch Res-Lok, as with the 4-inch Res-Lok, does not obsolete any of our existing products it fills a need for capability in its own right, in this instance, between the 7-inch and 10-inch filter series.

To illustrate, a Res-Lok 2028 filter (two 8-inch bandpass aperture coupled cavities) for an insertion loss of less than 1.5dB, will provide an unwanted signal attenuation of 38dB at ± 500 Khz. Our 7-inch equivalent for the same insertion loss, the 1-150-2S7, provides 32dB at ± 500 Khz and our 10-inch equivalent, the 1-150-2S10, provides 41dB attenuation at ± 500 Khz for the same insertion loss.

As with the 4-inch Res-Lok, aperture coupling is used wherever practical with the objectives of performance efficiency, economy and dependability. The result is a clean uncluttered appearance, the minimum of external cabling and lower coupling losses.

Eight-inch Res-Lok is also available in bandpass, band reject and Q-Circuit* models, to meet a wide range of requirements in the 25-54, 108-174, 225-400 and 406-512 Mhz frequency ranges.

Applications for 8-inch Res-Lok will be wherever greater than average selectivity is required with minimum physical size and ease of installation. Whether for rack mounting, floor, wall or ceiling mounting, Res-Lok compact size will make it simple and convenient.

*Res-Lok and Q-Circuit are patent trade marks of Sinclair Radio Laboratories.

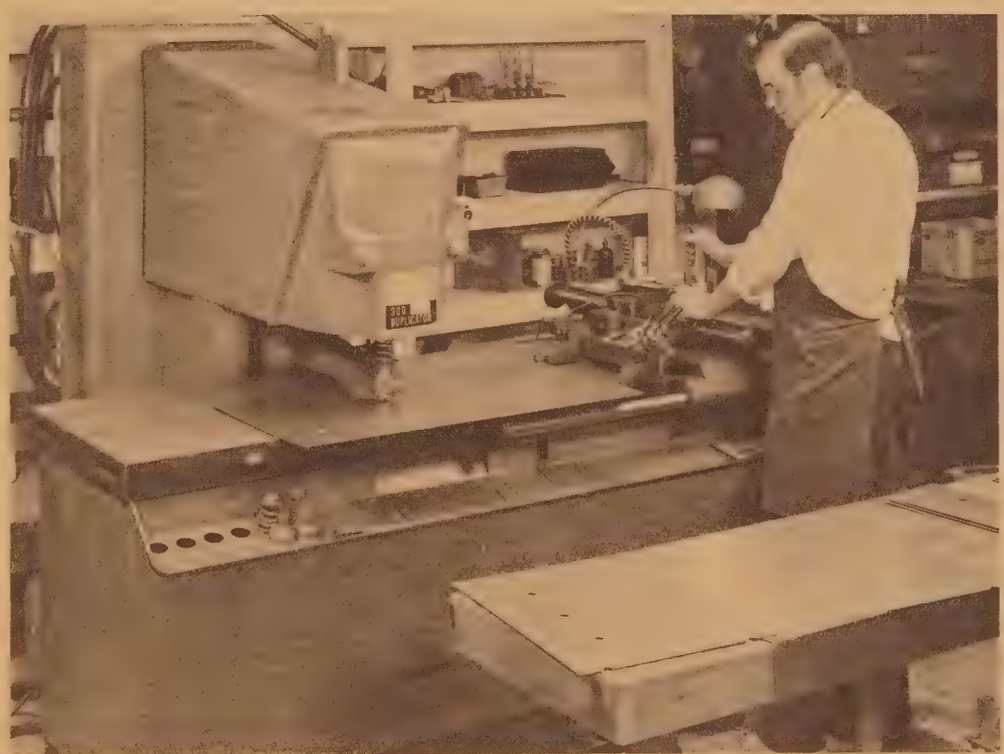
Views of the 8-inch Res-Lok.

Comshel for all seasons

As a result of Sinclair Radio Laboratories' ability to respond to unique customer requirements and its development of such products as the "Comshel" and "Comshel Junior" fiberglass communication shelters, and Res-Lok compact, high efficiency duplexers, the company was able to solve an unusual communications problem for a customer in one of the Middle East countries where the need was for several compact, self contained, transportable VHF automatic repeaters.

The problem was recently solved with Sinclair "Comshel Junior" fiberglass shelters, each housing: an antenna system; Res-Lok duplexer, for close frequency spacing, and a fully solid-state VHF automatic repeater powered by caustic potash batteries.

Close on the heels of this requirement came another for virtually identical repeaters, this time for the other end of the climatic scale, these are being placed into service in Newfoundland and Labrador.



Search for quality. To maintain Sinclair's reputation for high quality and performance, most phases of manufacture must be done inhouse. Sinclair's extensive inhouse induction welding and specialized production facilities combined with skilled people make it possible.

Lightning protection basics

Being struck by lightning is a hazard faced by all radio systems. Over the years many excellent papers have been published on this subject and considerable research has taken place.

However, the hazard remains. It can be minimized to the radio system if a few simple measures are taken.

1. Low resistance grounding of the antenna support mast or tower is most important, whether it is a simple tubular mast on the roof, a guyed tower or a self-supporting structure. In many instances, multiple ground rods may be necessary to achieve this. Guyed towers, for instance, not only should be grounded at the tower base but also at each guy anchor. Self-supporting towers should be grounded at the base of each tower leg. Those concrete footings make excellent insulators and must be by-passed to ground.
2. Always use an antenna that has built-in lightning protection. Many antennas achieve this by a shorted coaxial stub in the antenna. This device provides a direct path to ground for D.C. while offering an infinite resistance to RF at the operating frequency. Other antennas, by virtue of their design, are fully grounded to D.C. These are usually of exposed folded dipole design and are best illustrated by the Sinclair SRL-310, 224, 310 and 335 Series antennas.
3. Be sure the radio equipment itself is properly grounded. Many installations exist with the radio equipment not grounded at all. In some instances the 3-prong plug on the radio unit has been mated to a 2-prong A.C. power outlet, precluding a ground to the radio unit. Consider this sort of situation as being not at all uncommon. Imagine such a radio station connected by coaxial cable to an antenna atop an ungrounded tower, and your imagination can easily visualize the consequences of a lightning strike to the equipment and operator.

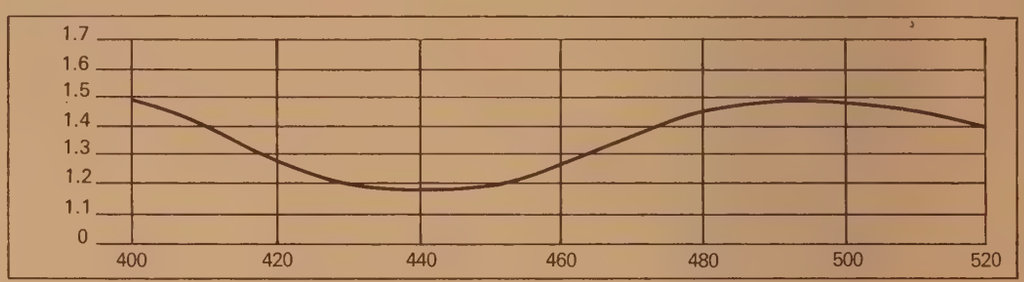
In the near future we plan to go into more detail on this important subject.

Wide bandwidth antennas

For duplexed, multi-channel and multi-coupled radio systems to function efficiently, antennas must be used that enable the radio system transmitters, irrespective of their output frequencies, to operate with a 1.5 to 1 or better VSWR into the transmission line.

Over the years, Sinclair research has developed a comprehensive range of antennas designed specifically for such applications, omnidirectional, offset pattern and directional, with gains ranging from unity to well in excess of 10.0 dBd.

Continuing research and development has been, and continues to be, our way of life. As a result, from time to time we reassess the performance of our antennas as it may relate to the changing needs of our customers. A case in point is the SRL-310 and 335 series broadband UHF base station antennas. Originally developed for use with multicoupled two-way radio systems where up to twenty or more transmitters and/or receivers may simultaneously use the same single antenna, the 310 and 335 series with their frequency ranges of 406-470 Mhz and 450-512 Mhz have met the need well. However, to meet changing requirements, we have redesigned both the 310 and 335 series antennas to operate over the entire frequency range of 406-512 Mhz with a VSWR of 1.5 to 1 or less.



Typical bandwidth curve for current production SRL-310 and 335 series antennas.

Logically, now that the 310 and 335 series antennas are usable over such a wide frequency range, our customers will consider multicoupling systems that will enable them to fully utilize the greater bandwidth capability. With this in mind, power handling capability becomes a consideration. The continuous power handling rating of these antennas ranges from 75 to 300 watts for the 310 series and 300 watts for the 335 series. These antennas are conservatively rated at these figures. Should higher power capability be a requirement, no problem, the antenna will be built to meet the higher power rating you need.

A typical VSWR versus bandwidth curve is shown for SRL-335-4. This curve effectively illustrates the performance capability of both the 310 and 335 series antennas.

These antennas, with their lower frequency equivalents in the 138-174 Mhz frequency range, the SRL-210 and SRL-235 series antennas, have been specifically designed for multicoupled service in the VHF and UHF bands. Higher power rated versions of the standard 300 watt, 210 and 235 series broadband antennas are also available on special order. In the design and manufacture of each of the antennas a major objective has always been minimum intermodulation response. That we have met this objective is proven by the many hundreds of these antennas that have been, and continue to provide, completely trouble free performance.

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More Lenient Interconnect Rules May be Formulated

FCC Safety and Special Radio Service Bureau Chief Charles Higginbotham recently said the bureau is doing some rethinking on its proposals for interconnection of private systems with the public telephone network. The result may be a more lenient approach to interconnection, he said. Higginbotham discussed interconnection and other subjects at a Senior Communications Symposium sponsored by the National Association of Business and Educational Radio. NABER held its symposium in conjunction with the annual banquet of the Radio Club of America in New York City. Other participants in the symposium included C. Phyll Horne of the Field Operations Bureau and John Miller of NASA. Stuart Meyer, E.F. Johnson Co., was chairman.

An afternoon roundtable sponsored by the Radio Club was moderated by Jerry Stover, chairman of the board of Communications Industries. Joseph F. Walker, vice president of Phillips Petroleum Communications, discussed offshore oil drilling as it relates to communications, and George Jacobs of the U.S. Board of International Broadcasting, covered developments on that subject.

Award recipients at the Radio Club banquet included Arthur Collins of Collins Radio (Armstrong Medal), William P. "Bill" Lear, Lear Siegler (Sarnoff Citation) John Rider, Rider Manuals (Batcher Memorial Award), and W.E.D. Stokes, inventor and past president of the Radio Club (Pioneer Award).

Dinner speaker was William J. Flener, associate administrator for air traffic control of the Federal Aviation Administration.

About 300 persons attended the banquet, and 150 additional registrants attended the day's sessions.

Two Additional Frequencies Allocated for Industrial Use

The FCC has allocated two additional frequencies (152.465 and 157.725 MHz) to the Taxicab Radio Services.

In order to avoid interference problems, the FCC said the new frequencies would be available in areas 50 miles or more from the center of the largest 40 urbanized areas.

The Commission proposed the allocations in a notice of proposed rulemaking January 14, 1976.

The frequencies involved are unallocated "bandedge" frequencies located between allocations to the Taxicab and Business Radio Services and are 15kHz from frequencies designated for paging operations in the Business Radio Service and from frequencies designated for two-way mobile radio operations in the Taxicab Radio Service.

They were requested for the Taxicab Radio Service by the International Taxicab Association (ITA). The Special Industrial Radio Service Association (SIRSA) asked the FCC to allocate the two frequencies to the Special Industrial Radio Service on a shared basis with the licensees in the Taxicab Radio Service, in areas located beyond 50 miles from the center of the largest 25 urbanized areas.

In prohibiting the new allocations from the 40 largest urbanized areas, the Commission said the interference potential would be substantial there. It said the extensive use of the adjacent channels in the Business Radio Service in those cities would prevent any use of the new frequencies for taxicab operations without interference.

Nevertheless, the FCC said, it appeared good use of these frequencies

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might be made in areas outside the major urban centers. It noted one of the comments indicated a need for frequencies in a number of small communities near military bases and in resort areas. SIRSA sought to obtain use of the two frequencies in rural, agricultural areas, and the Forest Products Industries Communications Association, in its comments described a need for frequencies in connection with forest products operations.

Noting that business paging on the adjacent frequencies had developed in the larger urban centers and that ITA had indicated it would not object to sharing the use of these frequencies with the Special Industrial licensees, the Commission said substantial requirements may be met and significant benefits may be obtained by making the two subject frequencies available in the lesser populated areas of the country for shared use in the Taxicab, Forest Products and the Special Industrial Radio Services.

A similar arrangement made for the geographical shared use of the Business Radio adjacent channels has worked well, the FCC noted.

Communications Adds Two Editors

The land mobile industry is growing and so is *Communications* magazine's editorial staff. Recently added as managing editor was Joan Perkins, who has been

Perkins

doing all the writing, editing, photography and design for an in-house publication for one of the nation's largest mortgage bankers. Joan has six years' experience in communications, and has an honors degree from Vassar College in Poughkeepsie, N.Y.

Also new with *Communications* magazine as associate editor is Steven Shaw who is a cum laude English graduate from Rhode Island College in Providence,

Shaw

Rhode Island. Steve has spent the last two and one-half years doing media planning and production of public information, speech writing, and press relations as the press secretary to the mayor of Providence, Rhode Island.

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FCC To Expand Business Hours

The FCC has voted to extend its office hours from 4:30 to 5:30 p.m. to provide improved service to the public.

Effective January 3, the new hours will be 8 a.m. to 5:30 p.m. for the Commission's offices located in Washington, including the District 24 office of the Field Operations Bureau, located at 1919 M Street, N.W.

The hours of all other field offices across the country are determined by local requirements and will remain unchanged. The new hours will not apply on weekends or legal holidays in the District of Columbia.

With implementation of the new hours, the public will be able to file petitions, pleadings, tariffs and other documents until 5:30 p.m.

The Commission said the new schedule would enable the public to do business with the FCC nine and a half hours each day. It will be of special benefit to persons dealing with the public information office, consumer affairs office, library, and agency reference rooms.

Also benefiting will be other agen-

INFO/CARD 8

cies and branches of government that work with the FCC, and the persons in time zones other than Eastern.

Duty schedules of individual employees are being arranged to ensure that the Commission's offices are adequately staffed to serve the public under the new schedule.

Splinter Decision Appeal Denied

The FCC has denied the Utilities Telecommunications Council (UTC) partial reconsideration of an FCC order allocating the splinter frequencies 154.45625 MHz and 154.47125 MHz for remote control, telemetry and other non-voice operations in the Industrial and Local Government Radio Services.

Because only 7.5 kHz separated these splinter frequencies from the 154.46375 MHz frequency used by power companies to regulate their electrical flow load, UTC argued that without proper coordination serious interference would result from stations operating on these frequencies.

The Commission pointed out that it had recognized the potential for adjacent channel interference and therefore had made available only those splinter frequencies where it felt the existing frequency coordination mechanism could prevent such interference.

In denying UTC's petitions, the FCC said it would continue to protect radio systems utilizing 154.46375 which provided vital electrical load management functions, as well as systems on adjacent frequencies.

ELT Inquiry Instituted by FCC

The Commission has instituted an inquiry into the problems and possible solutions of inadvertent emergency locator transmitter (ELT) activations occurring on the aeronautical emergency frequencies 121.5 and 243 MHz.

The Commission noted that an ELT could be activated in a number of ways, but, unless the activation was in response to an emergency situation, signals inadvertently activated created harmful interference to the aeronautical emergency frequencies 121.5 and 243 MHz.

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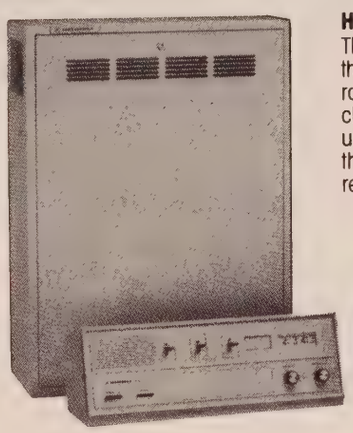

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Ill., the Commission found that 6,603 ELT activations were reported to the center in 1975.

It was the large number of inadvertent activations — 6,549 — causing harmful interference to the emergency frequencies that prompted initiation of this proceeding, the Commission said. Ninety percent of the inadvertently activated transmitters usually are located on or adjacent to airport landing areas, it noted.

Generally, the FCC said, once an activated ELT signal has been reported to the AFRCC (the reporting time ranges from a few minutes to a few hours), the time required to locate the ELT normally varies between 2-5 hours.

The main weakness in the existing distress system, the Commission said, was the lack of monitoring facilities to detect and localize the source of transmissions to a specific area.

As a solution to this problem, the Commission said it had considered requiring licensees of aeronautical advisory (UNICOM) stations to monitor 121.5 and/or 243 MHz at uncontrolled airports. (UNICOM stations are used for advisory and civil defense communications primarily with private aircraft stations.)

The Commission said it anticipated that monitoring and the continued voluntary effort of airport operators would result in a significant decrease in the duration of interference on the emergency frequencies.

Therefore, it requested comments on this proposal and recommendations concerning alternative solutions to the problem caused by large numbers of inadvertent ELT activations.

Comments may be filed by February 9, and reply comments by March 13.

Review of Grant Denied To California Licensees

The Commission has denied Industrail Communications Systems, Inc. of Los Angeles review of an FCC Review Board decision granting Radio Dispatch Corp. (RDC) of Pomona and Mobilfone, Inc. of Los Angeles additional two-way radio facilities in the Domestic Public Land Mobile Radio Services (DPLMRS).

It also held in abeyance the Review Board's grant of RDC's construction permit for Channel 25 (454.125 MHz) at its station KMD992 until final resolution of a petition by Industrial to enlarge issues in the case.

Mobilfone and RDC sought the use of Channels 23 and 25 respectively while Industrial had requested both channels.

In denying Industrial's application for review, the Commission said it would hold in abeyance the grant to RDC until resolution of Industrial's petition to enlarge the issues, reopen the record and remand the proceedings for further hearings on RDC's basic qualifications to be a licensee. Industrial's petition was based on allegations that an RDC principal had committed perjury in a proceeding before a state regulatory agency.

However, the FCC said, final action on the DPLMRS applications of Mobilfone and Industrial would not be delayed inasmuch as the resolution of Industrial's petition would have no effect upon its disqualification nor on the ultimate disposition of Mobilfone's application. It added that Industrial and Mobilfone could maintain their status in Docket 20084 and participate in any further proceedings. □

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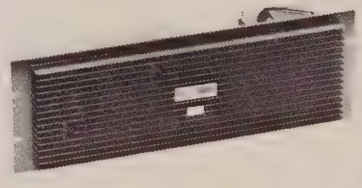

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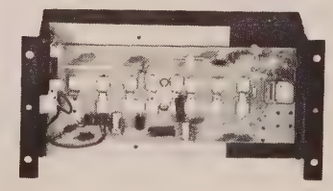

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INFO/CARD 13

Johnson Closes CB Plant; Motorola May Win LA Bid

E.F. Johnson Co. is closing its citizens band radio manufacturing facility in Clear Lake, Iowa, during the first quarter of next year. Richard Westrum, senior vice president of the company, reported that the closing is a direct result of the impact of Japanese imports of CB radios. Johnson says that CB sales will be reduced to five percent of total business; they had amounted to 75 percent of sales at the height of the CB boom. Johnson also has required relief from the **U.S. International Trade Commission** in the form of import tariff increases. The six ITC commissioners are expected to receive a report from aides in January, with recommendations for the President due on February 2.

Motorola apparently has emerged as the winner of a hotly contested $29 million contract for communications equipment for the **Los Angeles** police. A spokesman for Motorola said the company has the "recommendation to get the bid," from police chief Edward Davis. The recommendation must be approved by the City Council. Under an earlier decision, **System Development Corp.** would have provided computer-aided dispatch equipment valued at $20 million, and Motorola would have provided radio equipment estimated at $7-9 million. SDC says it will ask for an audit of cost figures before the City Council considers the recommendation. SDC proposes use of four Digital Equipment Corp. computers, E-Systems MDT 800 terminals for patrol cars, and General Electric radios. Motorola proposes use of two IBM 3031 computers and its own radios and mobile data terminals.

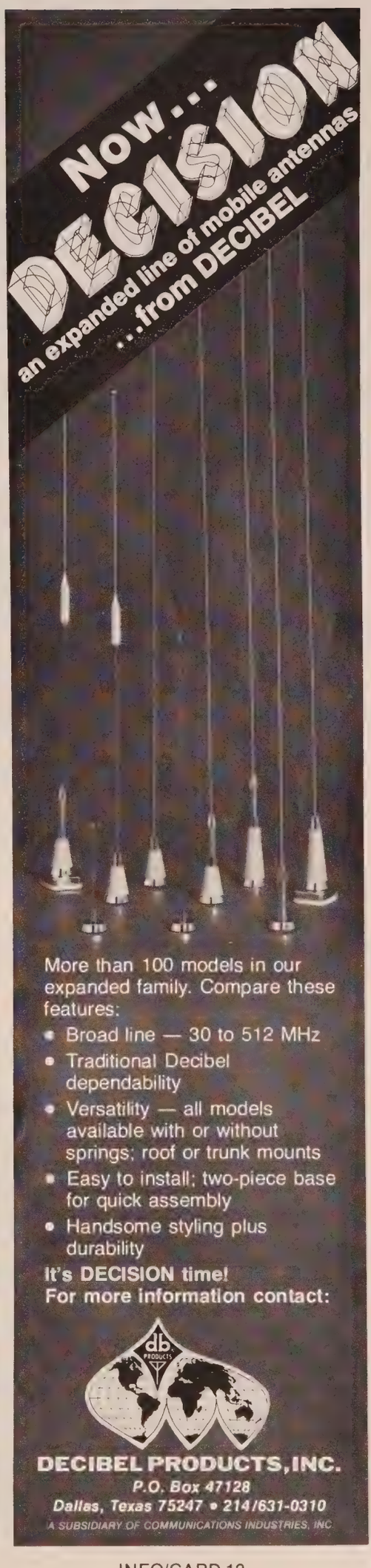
Motorola also reportedly is the apparent winner of a contract for base stations for **Los Angeles County**. These bases would be utilized in a $4 million emergency communications system that incorporates biotelemetry equipment and covers 135 ambulances and 25 hospitals.

Severe skill shortages in several telecommunications disciplines, inflation and record hiring all served to increase salary levels throughout the industry, reports Jay Jacobson of **Personnel Resources**. "1977 was by far the best year we have ever seen for corporate telecommunications openings for analysts, supervisors and managers," Jacobson said. Most of these openings have been in the starting salary of $15-27,000. Free copies of the salary survey are available from Personnel Resources, Suite 1234, 342 Madison Ave., N.Y., N.Y. 10017.

Audio call boxes and microwave radio transmission links will be installed in Brooklyn, Queens, Manhattan and the Bronx by **GTE International Systems Corp.** Equipment will be supplied to the **Emergency Medical Service Division of the New York City Health and Hospitals Corp.** It includes **GTE Lenkurt** radios and multiplexers.

Richard E. Williams, retired founder, chairman and chief scientist of **Scope Inc.**, has formed a new company, **NUMA Corp.**, with headquarters in Orlando, Florida. Vice president of the firm is Howard Howland, formerly president of one of Scope's subsidiaries and a co-founder of the **Repco Inc.** product line. NUMA will specialize in products and systems which facilitate the optimal transfer of energy. The company's first product is a spectrum conservation unit that digitizes speech.

David Brauch and Sara Sato, who were formerly with **General Electric Mobile Sales,** Palo Alto, California, and who have joined **Cal-Com Systems,** San Jose, report they have sold over $150,000 in new RCA "Veetac" radios in one month. 1978 projected sales are $750,000. □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An Overview of Signaling Techniques In Two-Way Radio and Paging

By Tony O. Crady
Automated Industrial Electronics
Batesburg, South Carolina

In two-way radio applications, probably the most well known use of tone signaling is in continuous tone controlled squelch systems. CTCSS was developed in order to allow multiple use of one RF channel. The number of users sharing one RF channel is limited by the types of systems involved. For example, a cab company with several hundred mobiles will completely tie up a channel for its own use. On the other hand, 10 or more small systems consisting of a base and one to five mobiles or portables each could conveniently share the same RF channel.

Most manufacturers of two-way radio offer CTCSS as an option or accessory item to the radio. Some radios are equipped so that the tone squelch option is a plug-in module containing both encode and decode capability. In this case, conversion to tone controlled squelch is simply a matter of removing a jumper and plugging a module in. With other types of equipment not offering plug-in capability, conversion to CTCSS normally consists of connecting seven lines between the radio and the tone squelch unit. These lines would be: supply voltage, ground, tone input to the tone squelch module, tone output to the transmitter from the tone squelch module, an audio gating output from the module to the receiver audio section, a TX/RX line, a disable line normally connected to the mike chip or handset hand-up bracket. A block diagram, Figure 1, shows the typical connection between receiver and tone squelch systems.

Following the diagram, tone is taken from the receiver discriminator output and applied to the tone squelch circuit. Normally, the tone squelch unit includes a low pass filter designed to cut off at approximately 250 Hz. This filter is required to prevent speech components from triggering the squelch gate and opening the receiver audio section during an undesired transmission. When the proper tone is received, the tone squelch module activates the squelch gate if the noise operated sequelch circuit has seen sufficient reduction of noise to cause it to operate. The tone squelch circuit is disabled by picking up the handset or mike thereby reverting the radio to normal noise operated squelch. This is required so that before the transmitter is keyed, the channel can be monitored for activity.

Once the channel has been monitored and the push-to-talk button has been depressed, the tone squelch circuit is changed via the TX/RX line from a decode circuit to

Figure 1.

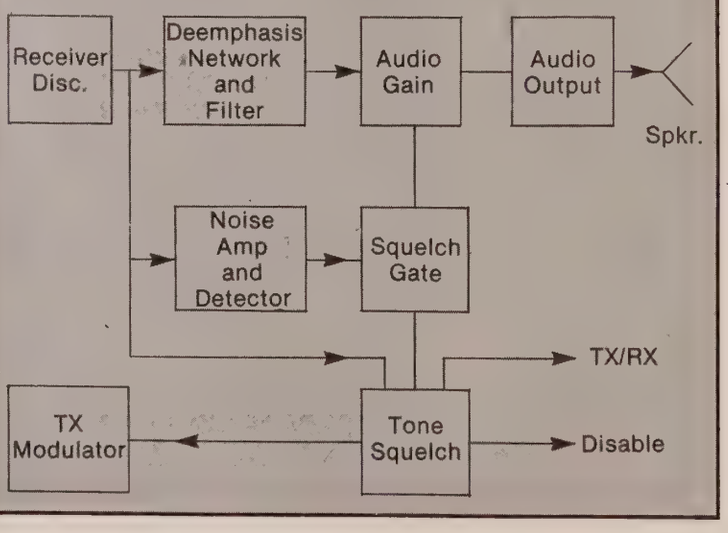
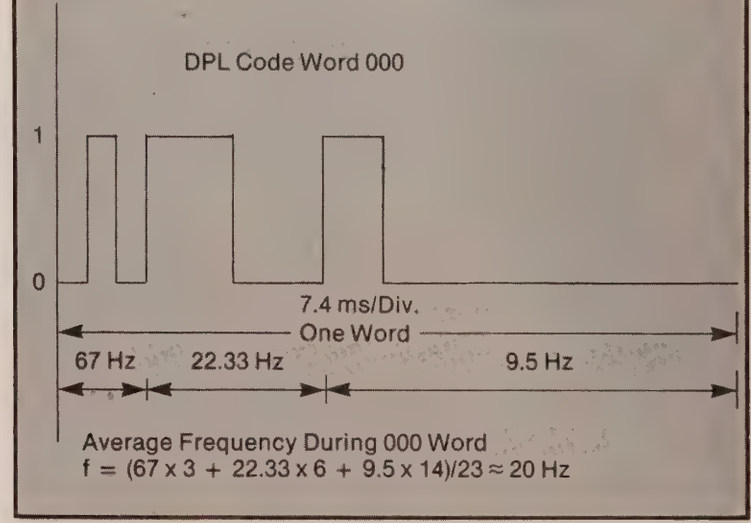


Figure 2.



an encode circuit. In the encoding mode, the tone squelch circuit applies the proper tone to the transmitter modulator at a sufficient level to produce approximately .750 kHz deviation at the transmitter output frequency.

Sub-Audible Tone Generation

A popular technique used for generation of sub-audible tones is to place an electro-mechanical device (resonant reed) in the feedback loop of an oscillator. A resonant reed, when excited with an electrical impulse, will oscillate at the frequency to which it is tuned. The principals of operation of a resonant reed are similar to those of a tuning fork. Therefore, tuning is accomplished mechanically by trimming the length of the tines. Because of the mechanical tuning involved, this type of device offers a high degree of stability. Resonant reeds tuned to any of the EIA designated tone frequencies are offered by several companies.

When decoding the sub-audible tones, the resonant reed can be switched out of the feed back loop of an oscillator circuit and used as a bandpass selective network between gain stages within the tone squelch module. The bandpass center frequency will be the same as that to which the reed is tuned. After passing through the selectivity package which insures that the incoming tone is of the correct frequency, the tone is amplified and detected by a diode or pair of diodes. The resultant DC level change is then used to turn on the squelch gate.

Another circuit frequently used for generation and detection of continuous tones is the active filter. In this case, high gain operational amplifiers are configured to form a bandpass characteristic centered about the desirable tone. As with the tuning fork type circuit above, the bandpass determining elements are switched into an oscillator feed back circuit for encoding purposes. Detection and gating functions are similar to the above. Normally, the bandpass determining elements in an active filter are resistors and capacitors. By using variable resistors, the bandpass and frequency of oscillation can be tuned. This feature gives the active filter circuit an advantage over the resonant reed circuit in that to change a tone frequency, it is necessary only to tune to a new frequency. A drawback is that long term stability of the active filter is not generally equal to that of a resonant reed.

There are several more types of circuits that have been used or are currently being used for encoding and decoding sub-audible tones. All of the various types have essentially the same operating characteristics.

In some applications, the slow system response of sub-audible tone controlled squelch is objectionable. A typical system response (time between encoder start-up and receiver squelch gate opening) is 350ms.

Heavy Channel Usage

System response time is a problem of little consequence when compared to the problems created by heavy channel usage. First of all, there are only 33 designated tone frequencies available between 67 Hz and 250 Hz. In some areas, congestion is so great that the tunable tone squelch circuits are tuned to a frequency between the designated tones. This creates another problem in that most decoder bandwidths are too wide to reject the tone that has been tuned between designated frequencies. When guidelines for CTCSS were originated, an Electronics Industries Association (EIA) committee carefully selected the 33 tones to minimize adjacent tone interference, tone harmonic interference, tone intermod and power line interference.

An alternative to sub-audible CTCSS is audible CTCSS. The applications of audible continuous tone control are limited to those transmissions not requiring voice. An example of this type system would be a simple paging system (tone only). This system overcomes the slow response problem of the sub-audible system but audible control is unreliable on shared RF channels. Falsing will occur when speech components of an undesired transmission fall within the bandpass of the decoder. Encoding and decoding circuits for audible tone control are similar to those required for sub-audible.

Another method of signaling used to access a receiver is single tone burst. Both audible and sub-audible tone burst are used. When tone burst is used, the encoder is designed to turn on when the transmitter is keyed. Then, after a preset time, the encoder will turn off. In the receiver, the decoder is designed so that the squelch gate will not open until the tone has been present a predetermined time. A long access time reduces the tendency to false during voice transmission of channel. For example, it would be rare that speech components within the decoder bandwidth would be held for one second or more. Single tone burst is used frequently in repeater systems for mobile to repeater access.

Digital Squelch

The most unique substitute for CTCSS which has been developed by a manufacturer of two-way radios is Digital Private Line™ (DPL) from Motorola. The clock frequency of DPL is 134 Hz, therefore, DPL is in the sub-

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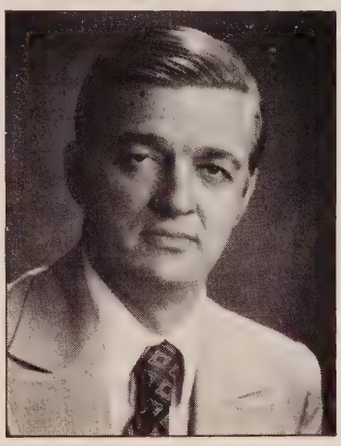

Tony O. Crady founded Automated Industrial Electronics in August 1974. He previously served as a design engineer with Lecom and Westinghouse Air Brake Co. Earlier, Crady was an engineer with Hammerlund Manufacturing Co. and an engineering technician with Aerotron, Inc. He attended Navy ET school and work on shipboard radar for two years. Crady holds an electronic engineering degree with specialization in communication from the University of South Carolina.

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audible range and all codes will have an average frequency of less than 134 Hz. With this system, a 23-bit word is generated logically and transmitted continuously.

A bit occupies a time frame of 7.4ms. For discussion, consider logic low to be 0 and logic high to be +5 VDC. An example DPL code (000) consists of 1 bit low, 1 bit high, one bit low, three bits high, three bits low, two bits high, 12 bits low. Correlating to frequency, this code has an average frequency of approximately 20 Hz. Figure 2 shows the DPL code 000 and derivation of average frequency. Other DPL codes have fewer transitions during the time period of the 23-bit word and as a result have a lower average frequency.

All circuitry for generating and detecting the 23-bit word is contained in a single CMOS 24-pin LSI package. Programming of the DPL code is accomplished by strapping to ground or VCC 9 pins on the DPL chip. The chip is binary coded, henceforth, 2^9 (512) codes are available.

As with continuous tone controlled squelch, the encode function starts with transmitter keying. A minimum of 170ms must elapse before a complete 23-bit word is generated and transmitted. The word is continually repeated during transmissions. At the end of transmission, the DPL circuit stops generating the 23-bit word and starts generating a turn-off code. The turn-off code is generated for approximately 200ms after which the transmitter is keyed off. The reason for generating the turn-off code is to signal the receiver to shut down before the transmitter goes off the air. This eliminates the annoying squelch tail normally heard in the receiver when the transmitter goes off air.

Due to the small amount of phase shift developed by a low modulating frequency, phase modulated transmitters are not suitable for DPL. Direct FM transmitters respond well to the low average frequencies involved.

During receive, the DPL circuit changes functions and performs the decoding necessary to select the proper DPL code. Interface between the DPL circuit and the radio is similar to that of tone squelch shown in Figure 1.

Unlike tone controlled squelch, DPL does not require bandpass elements in the decoder. A simple low pass filter is used on the input of the decoder to attenuate unwanted high frequency components present at the output of the discriminator.

The DPL code present at the discriminator is an AC signal of low amplitude. The signal is amplified to a peak-to-peak level of approximately six volts and a logic low of 0 VDC is established. After signal processing, the DPL code is applied to the code input of the DPL chip. If the incoming code is that which is programmed by the nine program lines, the receiver squelch gate will open. A system response time equal to the generation of one complete 23-bit word is minimum. Maximum response time is equal to the transmission of two complete words. This response time range of 170ms to 340ms compares favorably to CTCSS.

Of particular importance to DPL is phase. It can be seen that the code 000 discussed above becomes a completely different code when inverted. This aspect of DPL becomes critical if a radio unit happens to be working through the repeater to another unit. If the repeater has an odd number of inverting gain stages, decoding of the 23-bit word would not occur. Also, in testing DPL equipped

MODEL 322

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receivers with various types of RF signal generators, it is necessary to know whether or not the modulating input signal is inverted.

Although DPL is now being used only as a substitute for CTCSS, the potential for other applications is great. The number of available codes would allow it to be used in a paging system of 512 calls. Changing the clock rate or inversion would result in an additional 512 codes available. An extremely reliable two-code paging system could be devised. In this case, instead of sending tone + tone, a transmitter could send code + code. Transmitter ID, community repeater access, and alarm systems are but a few more possible uses.

Sequential Tone Control

Sequential tone control involves the transmission and detection of two or more tones in sequence. The most familiar type of sequential tone control is the two-tone sequential paging system. With this system, tones in the frequency range of 67 Hz to 3,000 Hz are used. Circuits used for encoding and decoding of two-tone sequential are similar to those used for generation and detection of CTCSS. Both encoder and decoder have the added complexity of timing of tone duration and intertone gap.

The encoder for a two-tone paging system may be a desk-top unit containing as few as two call codes, or it may be a rack-mounted unit containing as many as 900 call codes. For the simple two-call system, two resonant reeds on different frequencies could be used. Labeling the reeds 1 and 2, one call code would be generated by a 1, 2 sequence. Another call code would be generated by a 2, 1 sequence. For the larger 900 code system, it is obvious that the number (30) of reeds or separate oscillators would be both cost and space prohibitive.

With the higher capacity call systems, a programmable synthesizer is normally used for generating the call codes. Solid state memory circuits are used to store the call codes. The memory, upon command, will program the synthesizer to generate the selected tone and time combination.

In addition to two-tone sequential signaling, there are systems using three, four and five tones in sequence. Except for five-tone, most sequential systems are slow, requiring two or more seconds for call completion. At the expense of speed, a high degree of reliability is gained by the use of three and four tones.

The same degree of reliability found in four-tone sequential can be achieved with a two-tone simultaneous burst in sequence with another two-tone simultaneous burst (2 + 2). The obvious advantage is four-tone reliability with system response time of two-tone sequential.

Generally, systems using more than two tones are not used for paging but rather in applications where reliability and freedom from falsing are very critical. Examples of these applications would be railway crossing controls and fire or theft alarm systems.

Tone control is being increasingly used for channel select, tone squelch disable and transmitter keying of two-way radios where land lines connect the dispatcher to the radio. Most phone companies are no longer providing DC lines, thereby resulting in the need for tone control.

The tone remote control sequence consists of a first

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tone, second tone and return to first tone at a reduced amplitude. The first tone is of 115ms duration, second tone of 40ms duration, after which the first tone is transmitted continuously. Tones in the frequency range of 1,000 Hz to 2,200 Hz are used to accommodate the high speed requirement of guard tone and function tone burst. The continuously transmitted holding tone would not be heard in the distant receiver due to the reduced level.

High Capacity Paging Systems

The most commonly known high capacity system is the five-tone sequential decimal digital system. Although known as five-tone sequential, as many as seven sequential tones can be involved depending upon battery save and dual address capability of the receiver.

The format of the five-tone address consists of a preamble of 690ms duration, a 45ms no-tone gap, the five-tone code, (each tone of 33ms duration) and either a 52ms gap or a 52ms dual address (second call) tone. The dual address tone is a special tone not used in the five-tone code or preamble.

The preamble is sent one time to alert up to 10,000 pagers that a message may be coming. Messages are grouped according to preamble and first tone of the five-tone sequence. Grouping of this sort is done to insure that all battery save receivers with a possibility of receiving a message will remain under full power for the duration of the transmission. It can be seen that in a system operating at full capacity, as little as 900ms or as long as 36 minutes may elapse before a call request results in a paging message completion.

To maximize RF channel usage, incoming call requests are stored by preamble and first digit. After all calls in one preamble and first digit group are completed, a second preamble is sent alerting another bank of 10,000 paging receivers of a potential call. In this manner, a single transmitter can handle as many as 16,000 calls per hour. By variation of the first digit, the system will accommodate 100,000 calls.

Encoders for five-tone systems consist of a generator capable of being programmed to the 12 discrete frequencies used (see Figure 3) and a timing system for generating the correct time slots and call storage. Of course, the encoder must interface to a transmitter so keying circuitry and audio processing would be included.

Figure 3.

Tone Number	Tone Frequency
0	600 Hz
1	741 Hz
2	882 Hz
3	1023 Hz
4	1164 Hz
5	1305 Hz
6	1446 Hz
7	1587 Hz
8	1728 Hz
9	1869 Hz
R	459 Hz
X	2010 Hz

Beginning with a call request, the sequence of events which takes place in the encoder and transmitter is as follows: (Assume this to be the first call to come in.)

1) Call request for code 1-23456X.

2) Switchboard operator enters code number into memory by keyboard. Code displayed on indicator for visual feedback.

3) After entering code, operator pushes send button which activates the transmitter.

4) Since this is the first call to come in, the tone generator is programmed to generate the entire sequence. The sequence is transmitted and if additional call requests have not been received, the transmitter will shut down.

Now, if we assume that the call request was not the first to come in, events 1 and 2 would remain the same. Event 3 would change in that the transmitter is already on the air. In this case, the call would be stored in memory with other calls having the same preamble and first digit. When the preceding calls have been retrieved and transmitted, the tone generator would be programmed to generate the 23456X sequence, excluding the preamble since it has already been sent. All other calls beginning with 1-2 will be sent before the transmitter shuts down or sends out a different preamble, first digit combination.

From a systems aspect, the paging receiver/decoder is simple relative to the transmitter/encoder. The receiver is required to answer to two calls maximum. Other criteria makes the receiver a very complex unit.

The receiver must be able to decode any combination of preamble and five or six digits of code. Programming of the decoder is accomplished by a code plug which contains the desired code. Code plugs are supplied by the receiver manufacturer or, with proper equipment, blanks can be coded in the field.

The six-digit code (seven with dual address) the receiver gets is a sequence of tones which are detected by the discriminator and then decoded. The tone decoder utilizes a switchable tone filter which is programmed by the code plug. Using another example, code 5-43211 (seventh slot blank indicates no dual address), the switchable filter would first be tuned to 1305 Hz. If a carrier modulated with 1305 Hz is received for 690ms, the filter is switched to 1164 Hz. The decoder then waits for 45ms to receive the 1164 Hz tone. The 1164 Hz tone must remain for 33ms after which the filter is switched to 1023 Hz. The filter is then switched through 882 Hz and 741 Hz providing these tones have been transmitted in sequence for 33ms each. The repeated 1 would not be transmitted. Instead of a repeated transmission of 741 Hz, the repeat tone of 459 Hz will be transmitted. This is done to prevent loss of synchronization by the receiver. When the last digit has been received and decoded, the audio circuit is gated on and the pager emits an alert tone.

HICAP Digital Paging System

Another important high capacity paging system is the HICAP developed by Martin Marietta Corporation. One of the design criteria of the system was to provide enough codes to handle the paging requirements for an entire major metropolitan area.

The digital word comprising a pager address consists of a 4-bit sync pattern, one 16-bit pager address, 15 address

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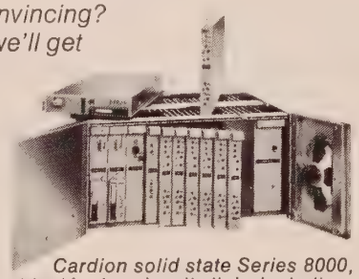

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error-correcting bits and one parity bit on the entire word. All 16 pager address bits are programmable allowing a maximum capacity of 2^{16} (65536) individual addresses. Advertised capacity of the basic system is 60,000. Expansion to 2,100,000 can be obtained by using a larger address and reducing the number of error correcting bits.

Multiple Transmitters Cover Area

The HICAP system was designed to use multiple transmitters located so that the antennas' radiation patterns would completely cover the entire area in which the pagers were being used. The transmitters are keyed sequentially so that a given pager address will be transmitted eight times. Where more than eight transmitters are required to cover an area, they would be placed in groups. Any group may have more than one transmitter, but only eight groups are used. Out of an eight-second time slot, only one transmitter or one group of transmitters is on at any given time. In a group of transmitters, the antennas' patterns are such that they do not overlap. This is done to prevent a receiver from getting two or more signals simultaneously. The eight-second time slot is called a major frame. Each transmitter, or group of transmitters, is on for a one-second slot in the major frame. This one-second period is called a minor frame.

A minor frame format consists of 12 zero bits for transmitter turn-on, three 36-signal acquisition words consisting of a 4-bit sync pattern (sync A) followed by 34 zero bits and 30 thirty-six bit receiver addresses to equal the system data rate of 1,200 bits per second. The 36-bit receiver address consists of a 4-bit area code (sync B), the 16-bit receiver address valve, 15 bits of error correction and a one-bit parity check. All addresses within the minor frame except the first include sync B. The first address includes sync A. A minor frame is transmitted by each transmitter or group of transmitters in sequence for a total of eight times or a major frame.

Although only 30ms (1 bit/1,200 bits per sec. x 36 bits) is required for one transmission of a receiver address, just 30 addresses are transmitted during an eight-second period. This is due to the sequencing of transmitters necessary to cover an entire area and to achieve the maximum reliability of the system. System paging rate is then 30/8 (3.75) per second or 13,500 paging calls per hour.

After each major frame is completed, 30 new calls are accepted and another major frame begins. This will continue as long as call requests come in. When call requests dwindle to a point insufficient to fill a minor frame, the empty slots are filled with a dummy address (idle code). A minor frame may consist of one valid address and 29 dummy addresses.

Unlike other paging receivers, the HICAP receiver incorporates a signal-to-noise detection circuit which determines whether or not it will try to decode an incoming bit stream. For example, if a receiver is in a location where it receives a poor quality signal from the transmitter(s) occupying minor frame one [first transmitter(s) in the keying sequence], it will not attempt decoding. The receiver will inspect each minor frame until it receives a signal of decoding quality. Once the unit acquires a minor frame of sufficient signal level, it synchronizes with the system by decoding the entire minor frame selected. If its address was not in the frame, major portions of the receiver will be turned off for just under seven seconds. Shortly before the minor frame selected comes up again, full power will be restored to the receiver and it will examine the 30 new addresses.

This sequence will be continually repeated unless the user moves to a location where the signal level in the selected time slot is of poor quality. When this occurs, the receiver will again seek a time frame in which signal quality is adequate for decoding. Battery saving is accomplished by this method in that portions of the receiver are on for only one second out of eight. A high degree of freedom from falsing is also achieved by the receivers' demand for a good signal-to-noise ratio. A good signal-to-noise ratio reduces bit error caused by noise to an almost non-existent level.

As in the five-tone system, the HICAP decoder is programmable to any of the possible 60,000 codes by a code plug. The code plugs are diode arrays with fusible links which cannot be altered once programmed. Code plug blanks can be field programmed with proper equipment. Code plug arrays with dual address capacity are offered by the manufacturer of the system.

In order to realize the full potential of the HICAP or high capacity five-tone systems discussed above, the use of call storage, automated call routing and verification is essential.

Dial Code Interrupted Tone Signaling

Dial interrupted tone is used in many RCC systems to access a mobile unit two-way radio telephone. The most commonly used tones in this applications are 2,805 and 1,600 Hz.

When the handset is taken off hook and the dial is cocked, the tone oscillator is turned on. On dial return to normal, the tone is interrupted with a make/break ratio of approximately 60/40. When dialing a one for example, the tone would be interrupted (turned off) for 40ms with 10pps dialer. Return to normal dial rate is determined by a governor with mechanical dialers or by a clock with electronic dial. At the end of dialing, a delay circuit holds the tone on for two to four seconds. After the delay, the tone goes off, signaling to the decoder in the receiver being addressed that all numbers have been dialed.

Decoders used in the receivers convert the interrupted tone into pulses which are counted and compared to the number assigned to that particular radiotelephone. Timing of the dialer is important to the decoder to separate digits. If the tone remains on for more than about 75ms in a 10pps system, the next pulse counted is considered to be part of a new digit dialed. If approximately two seconds elapse, dialing is considered complete. Assuming the correct number was dialed, the receiver will alert the user to an incoming call.

Transitional Dial Code (MTS)

Another way of accessing a two-way radio telephone is transitional tone dialing. In this system, an oscillator is toggled between 600 Hz and 1,500 Hz by a mechanical or electronically pulsed dialer.

The dial, when cocked, starts the oscillator. Upon return to normal, the oscillator output is changed from one fre-

uency to the other for each dial contact closure. For example, if the dial cocking starts the oscillator at 600 Hz, when a two is dialed, the oscillator would change to 1,500 Hz on the first dial contact closure and back to 600 Hz on the second closure. The next number dialed would start with 600 and toggle back to 600 or 1,500 depending on whether an odd or even digit is dialed. During the dial return to normal, the duty cycle of either tone is 50 percent.

The decoder detects transition of the tones. These transitions are counted and compared to the user number assigned. If no transition is detected for approximately 120ms, the next transition is considered part of the next digit. When a transition is not detected for approximately two seconds, dialing is considered complete. At this time, if the entire sequence matches the number assigned to the radio, an alert is emitted indicating to the user an incoming call.

IMTS Signaling

IMTS is employed with full duplex two-way radio telephones. At any given time, a unit not in use will be scanning several RF channels looking for an unused one. An unused channel is marked by an idle tone (200 Hz). When the mobile finds the idle tone, it locks on that channel.

The next incoming call to the terminal will be translated and the ANI (automatic number identification) number of the mobile being called will be out-pulsed on the marked idle channel. Before the ANI is transmitted, the idle tone is removed and a seize tone (1,800 Hz) is sent telling all mobiles not busy to prepare to receive ANI.

ANI is sent by alternately sending the seize and idle tones. Digit one would be a transition from seize to idle and back to seize. Duration of the bursts is 50ms in a 10pps system. Interdigit timing is 200-300ms. As soon as transmission of ANI begins on one channel, the idle tone is moved to another channel. All mobiles will stay on the channel transmitting the ANI until they receive a digit not compatible with their own number. Once the invalid number is detected, the mobile moves to the new idle channel.

The called unit will acknowledge receipt of ANI by sending back to the terminal an 800ms burst of guard tone (2,150 Hz). When the terminal receives acknowledgement of ANI, it begins transmitting the alert (ringing) signal.

When the mobile answers, it sends back to the terminal a 400ms connect tone (1,633 Hz) telling the terminal that conversation can begin.

Upon completion of the conversation (handset hang-up), the mobile will send to the terminal pulses of disconnect tone (1,336 Hz) and guard tone. After transmission of the disconnect signal, the mobile begins scanning for the unused channel marked by the idle tone.

Summary

This article was intended to cover only those signaling techniques best known to people working in the two-way or paging communications field. Other very important methods including Touch-Tone™ and signaling requirements associated with voice security (scramblers) were not discussed due to their relative lack of application. □

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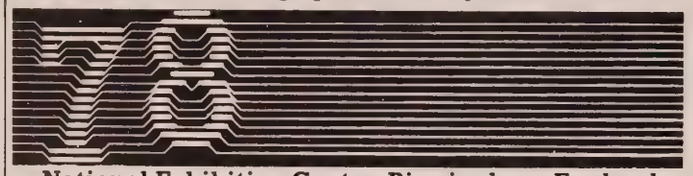

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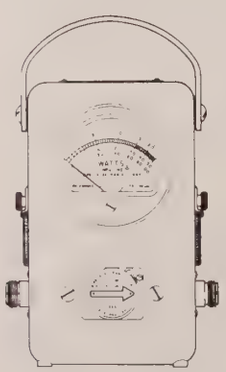

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Land Mobile Week Continues to Grow

Land Mobile Radio Week participation continues to grow. The week of activities, scheduled for March 20-24, 1978 at the Regency Inn in Denver, starts Monday, March 20 with the **National Business Radio Dealers Conference.**

Registration is from 8:00 a.m. to 5:00 p.m. daily during the conference. Exhibits will be open from 10 a.m. to noon, and lunch with a guest speaker will kick off the program. Panels on Monday include Five Dealers Who Made It Happen and More Dollars Through Better Marketing. A cocktail party is scheduled for Monday evening. Tuesday's program includes: Moneymaking Opportunities at 800 MHz, Progress Report from Private Mobile Radio Service Section (PMRSS) chairmen, a Dealer Delicatessen for lunch, motivational speaker Jim Newman, Can Repair Make You Rich, and exhibits. Wednesday's panels include Future Shock: The Impact of New Technologies, Ongoing Dealer Headaches and Their Cures, Financing Your Dealership, lunch with an FCC guest speaker, a Dealer Free-for-All with FCC representatives, and exhibits.

Contact *Communications* magazine, 1900 W. Yale Ave., Englewood, Colo. 80110, (303) 761-3770 for details. Registration is $95 including luncheons and the cocktail party; after February 6, registration will be $135.

Other groups selected to participate in Land Mobile Radio Week include the **IEEE Microwave Mobile Communications Symposium** and the **IEEE Microprocessor Tutorial Course,** both on Tuesday. All registration questions should be directed to Harold Christian at (303) 377-2004 or Nelson E. McNulty at (303) 233-6216.

Also scheduled for Tuesday is a meeting of the **Manufacturers Radio Service Advisory Committee.** For information, contact Gerald R. Lampear (313) 556-1978.

On Tuesday evening, the **National Association of Business and Educational Radio** will host a **Senior Communications Symposium** with well-known panelists who will comment on the current state of regulation and other topics. Stuart Meyer, E.F. Johnson Co., (202) 387-3100, will be in charge.

On Wednesday, the **IEEE Vehicular Technology Section Conference** will be held. To obtain copies of the advance program, contact John F. Shafer, U.S. Dept. of Commerce, National Bureau of Standards, Boulder, Colo. 80302, (303) 499-1000. Registrations are being handled by Harold Christian and Nelson McNulty, who are also handling registration for the Microwave and Microprocessor programs.

Bill Lear, famous inventor who founded Lear Siegler and Lear Jet, will be guest speaker at the **Radio Club of America** banquet scheduled for Wednesday evening. Local banquet coordinator is Douglas Johnson, Western Telecommunications, Box 22595, Wellshire Station, Denver, Colo. 80222, (303) 771-8200.

On Thursday, the **Land Mobile Communications Council** will meet for an all-day meeting. Mark Crosby of the Special Industrial Radio Service Association, 1901 N. Moore St., Suite 602, Rosslyn, Va. 22209, (703) 528-5115, is making arrangements.

Thursday evening, the **Colorado Council of Amateur Radio Clubs** in conjunction with **IEEE-VTS** will hold a technical symposium. Dr. James Andrews of the National Bureau of Standards, Boulder, Colo. 80302, (303) 499-1000, ext. 3259 is handling inquiries.

In addition, the **Electromagnetic Compatibility Group of IEEE** plans to meet during the Land Mobile Radio Week. Contact Jacqueline Janoski, (301) 267-2354 for information.

Forest Industries Telecommunications is planning a board of directors meeting during the week. Contact James Baker, P.O. Box 5446,

NABER directors and committee chairmen met recently in Phoenix. From left: Wylie Powell, Standard Electric, board chairman; Val Williams, NABER president and general manager; Richard Meyer, counsel to NABER; and James Ungry, United Airlines, board member.

Eugene, Ore. 97405, (503) 485-8441 for information.

The Microwave Council Inc. will meet all day Friday of Land Mobile Radio Week. Less Bayless, 1346 Connecticut Ave., N.W., Washington, D.C. (202) 296-5515 is in charge of the program.

Exhibit space (8 x 10' booths) is available for the entire week or for a portion of the week. Phil Cook, *Communications* magazine, (303) 761-3770 has details.

Skiers interested in cross-country ski information can obtain the latest data from Forrest Gagnon, United Airlines, 5350 S. Valentia Way, Englewood, Colo. 80110, (303) 779-2337. Downhill skiers should get in touch with David R. Barnett (S-0530), Martin Marietta, P.O. Box 179, Denver, Colo. 80201, (303) 973-3837.

Committee chairmen and board members of the **National Association of Business and Educational Radio** met recently in Phoenix. One result of the meeting was formation of an Agri-Community section of NABER to work on radio-related concerns within the agricultural industry. Membership in the new section is open to any NABER member with an interest in frequency concerns of: farmers, ranchers, food processors, warehousers, growers, stockmen, transporters, cotton ginners, silo operators, packers, etc. Frank Ashby of Pallitron Corp., Modesto, California, will serve as chairman of the group.

Committee reports from Private Mobile Radio Section chairmen indicated a high level of interest in that group's activities for dealers.

The Regulatory/Rules committee chaired by Cliff Bade of Cleveland Mobile Radio, has focused on modification of control station and control point rules, responsibilities of tower users, and transmitter power out requirements, as well as the possibility of using 12.5 KHz spacing at 450 MHz. The reversed frequency pairing proposal would assign mobiles to lower frequencies, bases to higher ones.

John Black of Radio Systems Inc., chairman of the Spectrum Management committee, noted that 32 persons are now beginning to provide nationwide information on frequency coordination in order to improve data base accuracy. Frank Gronert, Gronert Electronics, said the Professionalism committee has devised a proposed code of ethics and objectives for PMRSS members and is working on training and recruitment programs.

Dick Hoover, Troup Electronics, chairman of membership efforts, noted that PMRSS now has 438 members. □

CRYSTALS

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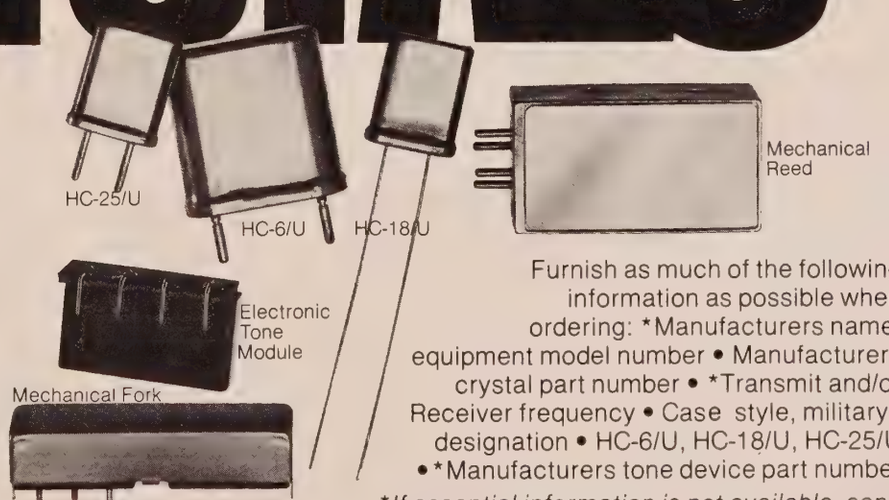

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INFO/CARD 14

Come to a Conference

On March 20, 21, 22 the Second Annual National Business Radio Dealers Conference will be held in Denver, Colorado at the Regency Inn. The conference is sponsored by *Communications* magazine.

The 1978 conference will follow the successful format pioneered at the first conference in Denver in 1977. Purpose of the conference is to allow dealers to exchange information in an informal, shirtsleeves workshop situation.

The National Business Radio Dealers Conference will form the nucleus of an industry-wide Land Mobile Radio Week, March 20-24, headquartered at the Regency. Other participating groups include: Vehicular Technology Group of IEEE, National Association of Business and Educational Radio, Radio Club of America, Land Mobile

Dealers in Denver.

Communications Council, IEEE Microprocessor Tutorial Course, IEEE Mobile Microwave
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nd Their Cures — Financing Your Dealership
n with FCC Guest Speaker — Dealer Free-for-All

ntative of the sessions planned for the National
nce. More program details will be available soon.

questions or need further information
tact Pat Wiesner at (303) 761-3770.

National Business Radio Dealers Conference

- ☐ Sign me up now for the Dealers Conference. Enclosed is my check for $95 which covers registration, materials, three luncheons and a cocktail party.
- ☐ Sign me up now, but bill me in February at $95. (Registration after Feb. 6 is $135.)
- ☐ I'm interested in Ladies Program information.

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National Business Radio Dealers Conference

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Communications Council, IEEE Microprocessor Tutorial Course, IEEE Mobile Microwave Symposium, American Radio Relay League. Forest Industries Telecommunications, Manufacturers' Radio Service Advisory Committee, IEEE Electromagnetic Compatibility Committee, Microwave Council, Inc. NABER Senior Communications Symposium.

Program Highlights:

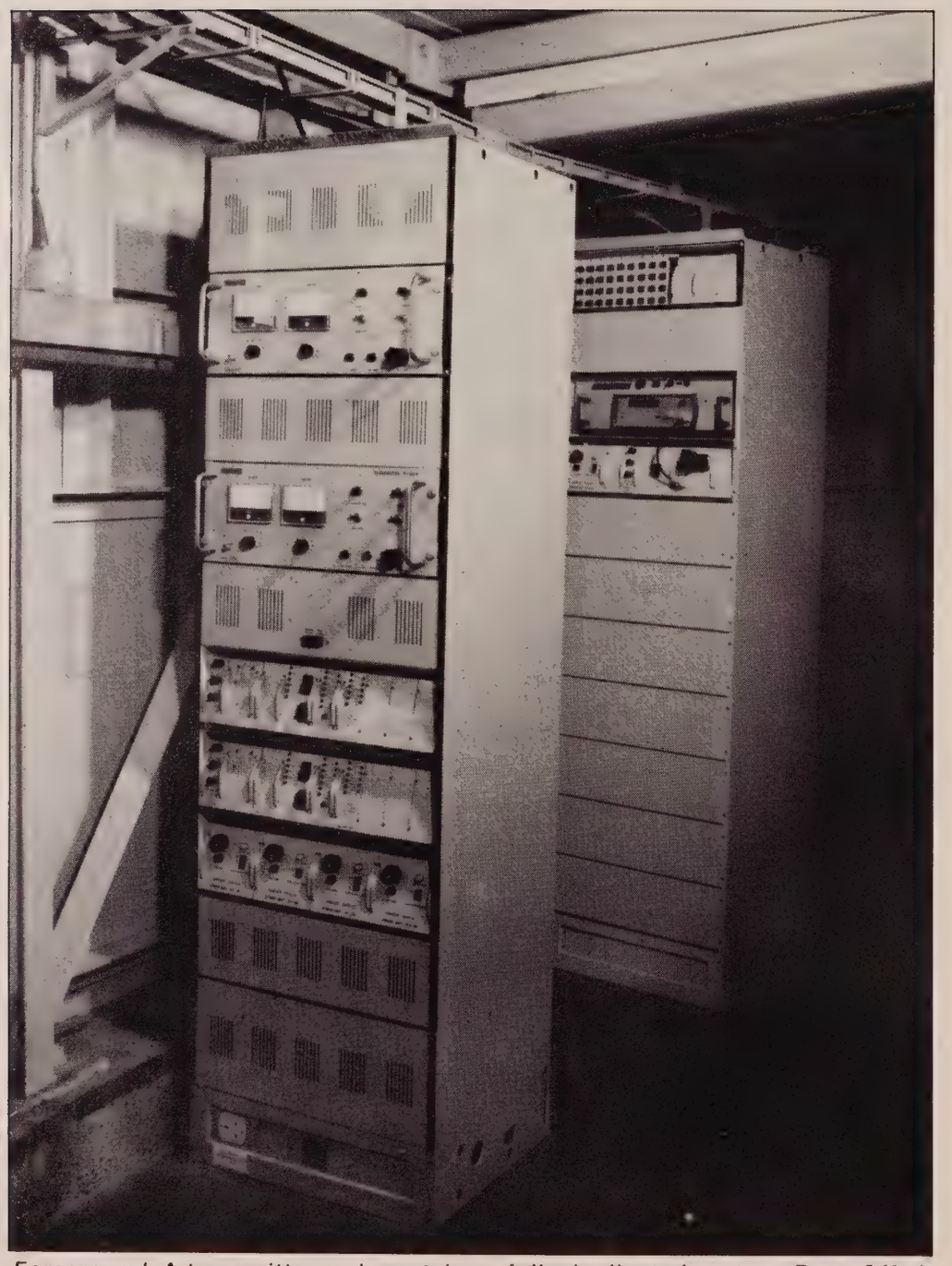
Five Dealers Who Made It Happen — More Dollars through Better Marketing
Exhibits and Hands-On Service Seminar — PMRSS Progress Report
Moneymaking Opportunities at 800 MHz — Can Repair Make You Rich?
Motivational Speaker — Future Shock: The Impact of New Technologies
Ongoing Dealer Headaches and Their Cures — Financing Your Dealership
Meet the Speakers — Luncheon with FCC Guest Speaker — Dealer Free-for-All

These highlights are representative of the sessions planned for the National Business Radio Dealers Conference. More program details will be available soon.

If you have any questions or need further information please contact Pat Wiesner at (303) 761-3770.

The Post Office Radiopaging Service

By Norman W. Brown
Post Office
Telecommunications Headquarters



Foreground: A transmitter rack contains a fully duplicated system. Rear: Off-air frequency measuring equipment monitors all transmitters.

London — Paging in the United Kingdom started in 1956 with a loop system installed in St. Thomas' tal, London, and typical of one of the early wide-area systems here was the Cambridge Medical Answering Service for Doctors, which opened in 1968. During the next few years several other small private systems were licensed, and during this period development in North America of pocket paging receivers operating in automatic systems attracted the attention of the UK Post Office Telecommunications Business. Thus the idea of a national service was born, but first it was decided to gain experience by implementing an automatic system to provide a radiopaging service covering a 900-square mile area around Reading, a medium-sized town 35 miles west of London.

Hence the "Thames Valley Radiopaging Service", as the Reading service is named, opened in January 1973 and proved an immediate success. Designed for national access, the system uses duplicated processor control and six 100-watt transmitters to transmit two-tone type signals to pocket pagers carried by more than 2,000 customers.

Success in Reading encouraged the construction of a 20,000 expandable to 100,000 capacity system for London. This was opened in December 1976 and with very little advertising has attracted 5,000 customers in the first nine months of operation.

The London system is designed to accept several types of pagers, the main requirement being that these should operate to a signaling speed of four-five calls per second and have an

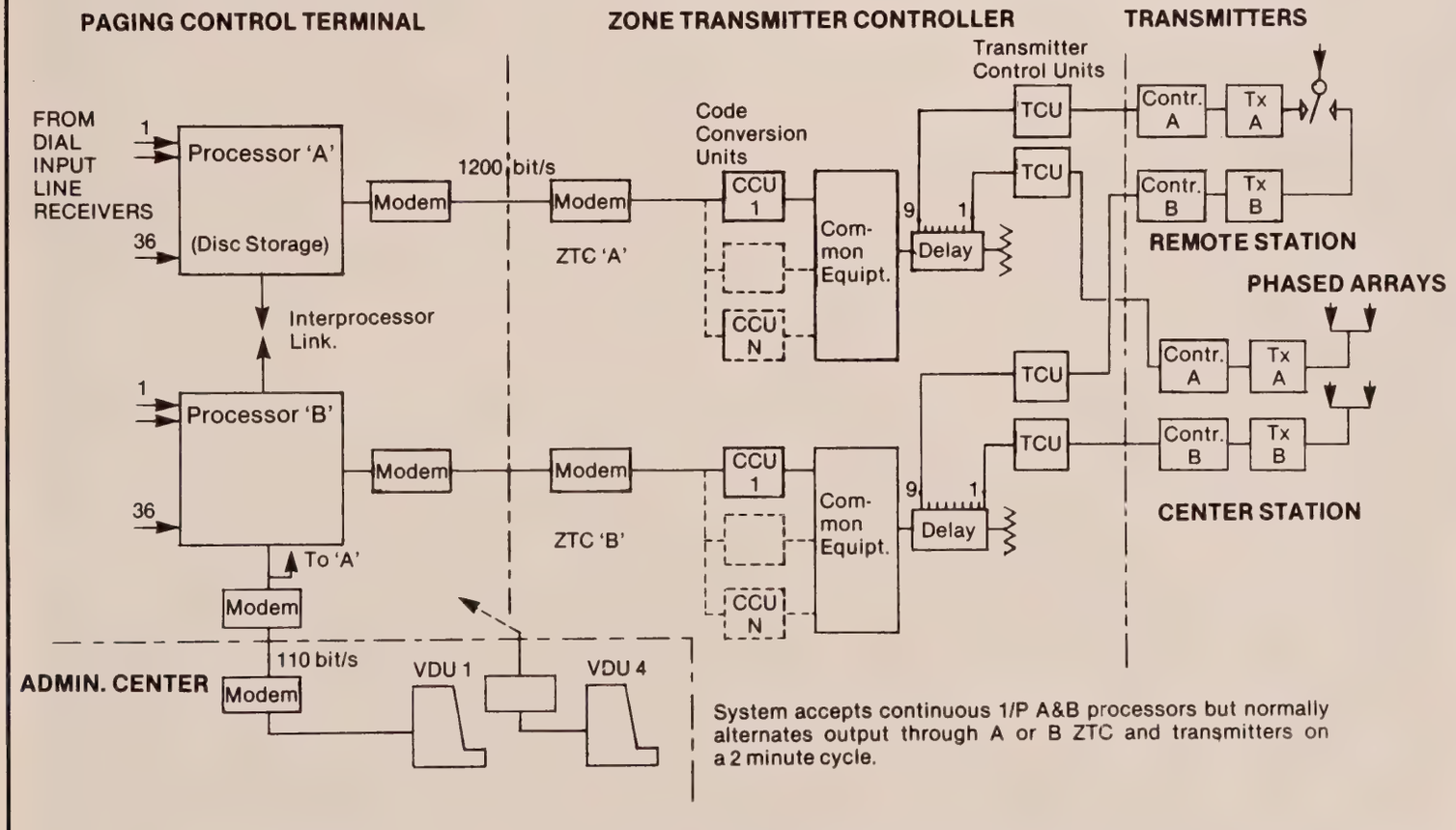
The Post Office of the United Kingdom has designed and installed a unique radiopaging system for the city of London. The system uses Zones Transmitter Controllers to provide a highly flexible operation.

average sensitivity of 10 μV/M or better. At present only one pager type is being marketed, but with the addition of Code Conversion Units (CCU) on each of the processor outputs, other types could easily be introduced.

To meet these requirements, the control terminal was specified to output each paging call in seven-bit start-stop characters of ASC II format for transmission over PO Telecommunications Business 1200 bit/s data links. Features of this terminal, supplied by Motorola, include call validation with a recorded announcement; remote access for four VDUs in the sales office with automatic updating between the fully redundant halves of the control terminal; fixed-head disc storage, and for additional security, an inverter power supply from the telephone exchange battery.

For interfacing with the data link, the PO Telecommunications Business designed a Zone Transmitter Controller (ZTC), the object being to provide a highly flexible system incorporating CCUs for digital and/or tone signaling pagers, with these to be obtained by normal competitive tendering. Briefly, the requirements were for pagers using a code catering for at least 100,000 receivers each with dual address, a memory for facility and a minimum battery life of three months. The manufacturer was also

LONDON RADIOPAGING SERVICE — SIMPLIFIED SCHEMATIC.



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INFO/CARD 18

required to supply three CCUs, one for each half system, and a spare. After due consideration the Multitone RB111, a multi-address digital type, was chosen and an initial contract placed for 10,000 pagers.

Transmitters for the project were specially designed by Redifon to meet a PO specification requiring: A 100-watt, solid-state, convection-cooled output; frequency stability of one part in 10^7 per month at 150 MHz; a switchable modulator, ±5 kHz FSK or FM, for digital or analog pagers respectively, and a standard logic interface for supervisory and control purposes.

For security, two transmitters have been provided at each site and these together with the 28V regulated PUs are all contained in a six-foot rack. At a few stations where protected AC is not available, power has been supplied from float-charged batteries. Also in the rack are the PO Telecommunications Business design controllers to interface the transmitters to the line network.

Where space has permitted their use, antennas of the 6 dB collinear type have been used to minimize the RF requirements from the transmitters, which have been designed to operate between 25 and 100W. Antenna gain is particularly useful in minimizing DC power requirements from the battery-powered stations. As in Reading, effective radiated powers of 100W are radiated with a quasi-synchronous frequency off-set pattern in the range 0 to 100 Hz.

Zone Transmitter Controller

As mentioned, the ZTC houses the CCUs for the particular pager in use and is capable of accommodating several other types. It is fully duplicated, each half being associated with a half terminal, and performs the following functions: 1) Data interchange with the terminal; 2) Remote control of transmitters; 3) Line equalization; 4) Indication of local and remote supervisory and alarm conditions; 5) Frequency monitoring of transmitters and 6) Line feed patching.

From the ZTC, two alternatively routed lines have been provided to each of the nine transmitting stations and for equalization these have been tapped along a 3ms delay line consisting of similar 25 μs sections. During adjustment, the central monitoring receiver was used to relay information on each line/transmitter combination. In its normal role, this "straight" receiver operates a counter to enable individual transmitters to be checked for frequency during idle periods between calls. A printer in the ZTC records these frequencies and, if necessary, adjustments are made at the remote station under guidance from the Control Centre.

System Operation

A four-digit national dialing code is used for routing telephone calls into the terminal, where the remaining six dialed digits are converted into binary coded decimal format. Validation and call queues are formed, according to pager type within the stores of each half of the terminal. The traffic flow is currently on a two-minute cycle per half system and as the call data passes into the associated half ZTC, the duplicated record in the other half terminal is erased. By this means the possibility of losing a call through equipment failure in the terminal is minimized.

At the ZTC the call data, which

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has been prefixed with a CCU address, is processed in the CCU to generate the pager codes. Before these are transmitted, all the transmitters are keyed and set for the appropriate modulation mode by means of a 12-bit word. Standard CCITT V23 1300/2100 Hz Datel is used for this purpose and confirmatory data is returned to the ZTC for supervisory and alarm purposes.

In the case of digital pagers, a Datel connection is maintained for paging call transmission, but if analog pagers had been used, the Datel link would have been disconnected at this stage while appropriate signaling tones directly modulated the transmitters. Transmitter turn-off is by means of a 3 kHz tone which is additionally used as a line continuity pilot during idle periods.

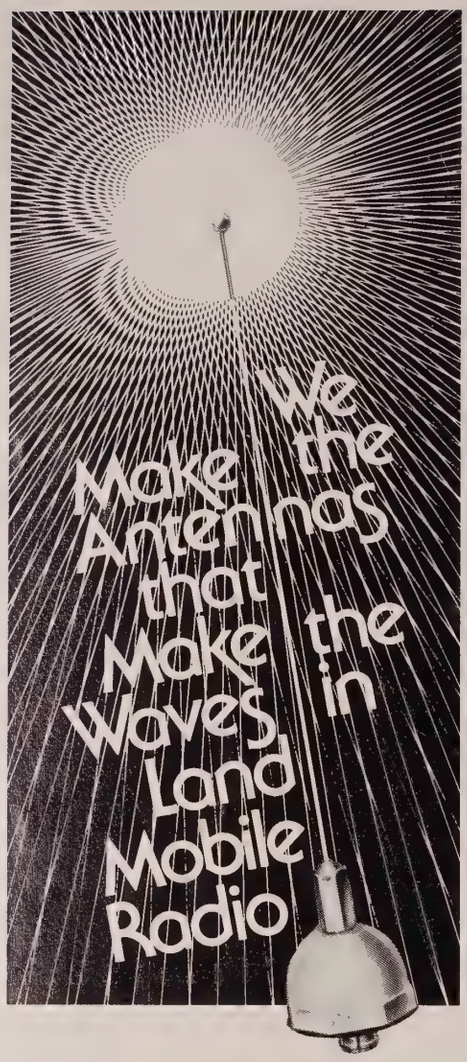
Radio Pager Sales

At the London Radiopaging Centre, the pre-coded pagers are allocated dialing codes known as "paging numbers" and the appropriate data is then fed into the terminal by one of the four VDUs. After checking for operation, the pager is normally mailed to the customer, though an over-the-counter service is available should a quick issue or replacement be required. To help in the recovery of lost pagers, a Freefone number has been printed on the pager identification label.

Quarter charges for the service are, single address: £21, dual address: £30. There is also an initial fee of £5 and a group call rental of £15 per group.

Standardization of Codes

The freedom to diversify in pager types is to be retained in the proposed national service, though it is hoped through cooperation between manufacturers participating in the Post Office Code Standard Advisory Group (POCSAG) will result in a consensus of opinion on the format of a standard code. This is likely to provide over 1M addresses and be compatible with the requirements of nationally operated systems. Hoped-for, long-term advantages include a degree of standardization in the processing and



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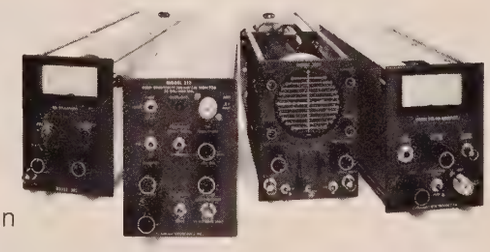

The new CE-4B Communications Monitor. Expanded main frame capability and a choice of 12 plug-ins to provide the highest performance possible, or the choice of a more economical system when you need it. All with the same field-proven reliability that Cushman has made an industry standard since we introduced the first monitor in 1959.

The CE-4B includes two new features on the monitor main frame: a high level output and audio synthesizer. To help you troubleshoot receivers, the high level output provides test signals up to 700 millivolts to 512 MHz, and 175 millivolts to 1000 MHz. The audio synthesizer gives you signaling tones accurate to ±.005% over a frequency range of 10.00 to 9999 Hz. This tone and an internal 1-kHz signal can be used to modulate the instrument simultaneously.

With the flexibility of picking the specific plug-in modules to match your requirements, you have the most powerful two-way radio test system available. The best equipped CE-4B will include a Model 301A or 311 oscilloscope and the universal Model 317 high sensitiviy AM/FM/SSB monitor. With these two plug-in modules you can service any kind of two-way radio from 10 kHz to 1000 MHz. Either off-the-air, or in the shop.

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The good idea is that it's possible to build a product that has a reasonable price, doesn't cost much to maintain, and will last, practically forever. People in other countries had done it. We figured we could too. So we . . .

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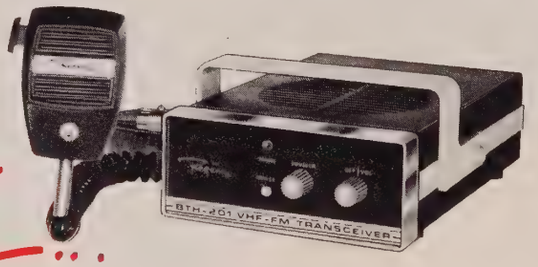

And we called it a BTH-201. It's been around over five years now. The orginals are still out there, still plugging away. At the time, some people said it was impossible to build a good 2-way radio for $299.* We proved them wrong. But we didn't rest on our laurels. What did we do?

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transmission equipment; better use of "air-time"; cheaper receivers, without need for a separate CCU for each manufacturer, with resultant encouragement to the smaller administrations and private operators to launch new services, possibly saving some spectrum by slowing the requirement for two-way radio communications.

1977 Target Date

The target is for this advisory group to have a fully defined and tested code by the end of 1977 or soon after. It is expected that within three years the "standard code" pagers will be available from many European and American sources.

A code has been tentatively selected which will cater up to one million users, each with four different types of call, and including a long message facility which may eventually be used for conveying the caller's telephone number or any other alphanumeric message. The transmission rate could be about 15 calls/second.

Within the UK an ultimate nationwide paging market of one million customers seems possible, and long-term plans to build up to this capacity are progressing on the basis of an interconnected system of paging control equipments (PCEs), each serving one or more zones. Customers would then elect to receive service in a chosen number of zones with the tariff adjusted accordingly. To prevent radio interference it is proposed to time sequence zones so that adjacent ones do not transmit in the same time frame. The zones, each containing upwards of 10 transmitters, will radiate their own "local" calls plus calls for "roamers" received over the data network from distant PCEs.

Returning to the present time, customer satisfaction with the London service is most encouraging, and it is possible that the London terminal may be used to provide service in another city until the first "national" PCE becomes available.

Acknowledgements

Acknowledgement is made to the senior director of Development of the Post Office for permission to make use of the information contained in this article and also to my many colleagues who are participating in the project. □

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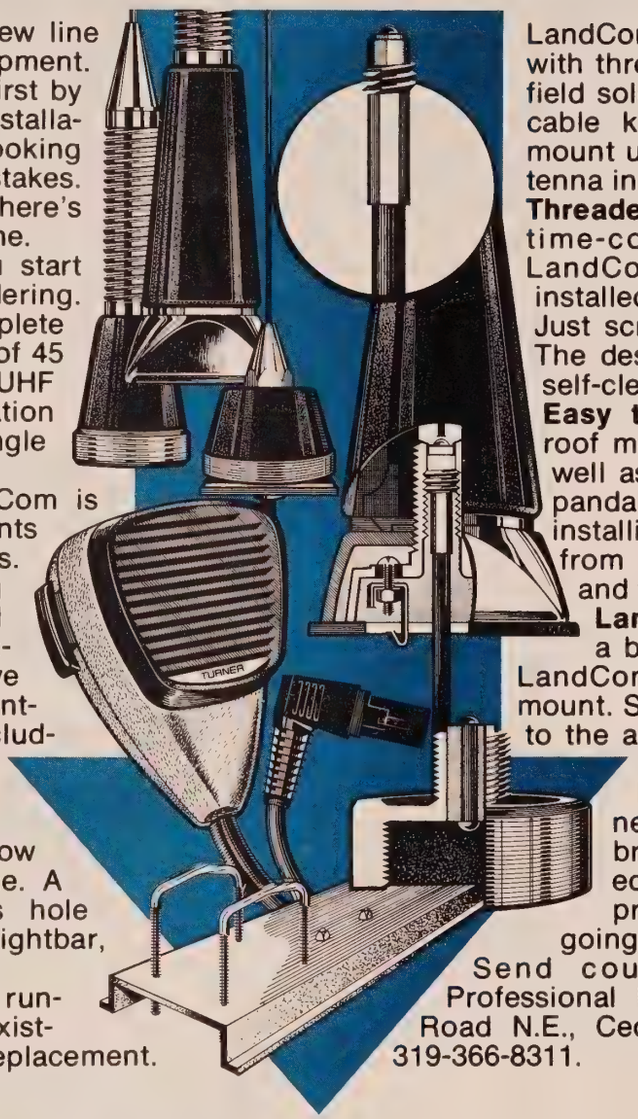

LandCom has an in-line connector kit with threaded connections. There's no field soldering. Just add the LandCom cable kit to the existing cable and mount up a replacement LandCom antenna in minutes.

Threaded antenna connectors. Avoid time-consuming field soldering. LandCom antennas have factory-installed threaded cable connectors. Just screw the cable into the mount. The design provides a spring-loaded, self-cleaning, water-tight contact.

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INFO/CARD 26

USI

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2805 ENCODERS FOR PORTABLES

MODEL 311 — At last, a sub-miniature, 1-1/2" x 2" x 5/16" completely self-contained, 2805 encoder for use with all hand-held portables. Has memory for redial of last number.

CONTROL HEAD TOUCH TONE ENCODER WITH ANI

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MODEL 237 — Mount over rotary dial cavity. Front installation, telephone style keyboard. Manual dialing plus 3 ANI sequences. Compatible with Fan-Tron ANI format.

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INFO/CARD 27

Bondon and Kroha Promoted

Repco Inc. has appointed **H.E. "Bill" Bailey** national account manager. Bailey previously was international major accounts executive.

Joel D. Dolin has been appointed president and chief executive officer of Leasametric, Division of Metric Resources Corp. Dolin is one of the three founders of Metric; he has served as executive vice president, marketing.

Under its Field Operations Bureau reorganization plan, the FCC has named three additional regional directors. They are: **Carl E. Pyron,** Atlanta; **Kent T. Crawford,** Chicago; **William E. Johnson,** Seattle. All three are engineers with previous FCC experience.

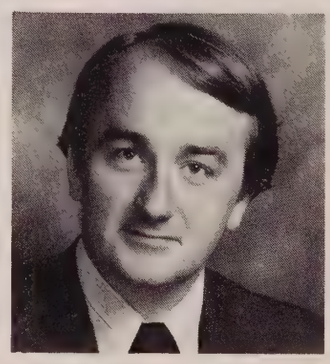
Lee F. Crowley, formerly manager, communications products engineering and product management for RCA's Mobile Communications Systems operation, has been named manager, engineering and technical services, a new position. **Albert R. Allen** is the new manager, technical services. Allen will be responsible for field and customer technical services, installation and maintenance, parts, accessories and training activities. He reports to Crowley. Also at RCA, **Henry H. Klerx,** formerly with the Broadcast Systems activity, becomes manager of business planning, a new staff position. Klerx will coordinate product, marketing and related planning activities for Avionics Systems, Broadcast Systems and Mobile Communications Systems.

At the recent Prodelin Inc. annual meeting, the board of directors elected **David L. Bondon** to president. Bondon has been division vice president in charge of the company's fiberglass manufacturing operations.

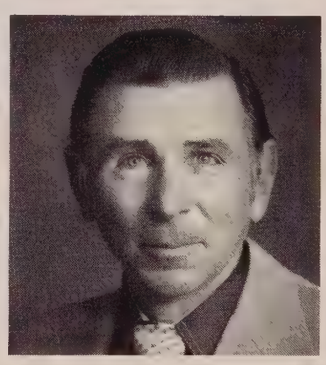
Donald L. Dandurand has been named account executive/sales engineer for Quintron Corp., announced **Alfons F. Goossens,** vice president. Dandurand has served with Multitone, Motorola and Illinois Bell.

Roger Ponto, previously national sales manager for Shure Brothers Inc., has joined Fleethart and Sullivan, Inc., Seattle-based manufacturers' representatives.

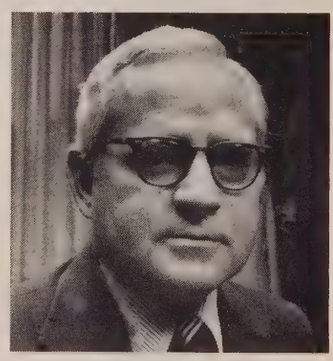
Brad Kroha has been promoted to vice president and assistant general manager of Motorola's Communications International Division. He has been director of international subsidiaries, and general manager of Canadian Motorola Electronics.



Bondon



Dandurand



Acker

Lawrence W. Katz has been named attorney-advisor to FCC Commissioner **Joseph R. Fogarty.** Katz formerly was chief of the Common Carrier Bureau's tariff proceedings branch.

New staff counsel for the International Municipal Signal Association is **Arlene J. Fischler.** Keller and Heckman, long-time general counsel for the association, will continue on retainer.

W. William Acker has been named to the newly-created position of executive vice president and chief operating officer of Kustom Electronics, Inc. Acker has served with RCA, IBM and Arthur D. Little. He has been a consultant for Kustom since June. □

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INFO/CARD 34

DTMF Signaling For Palo Alto's Fire Department

By Claude Davis
City of Palo Alto
Communications Division

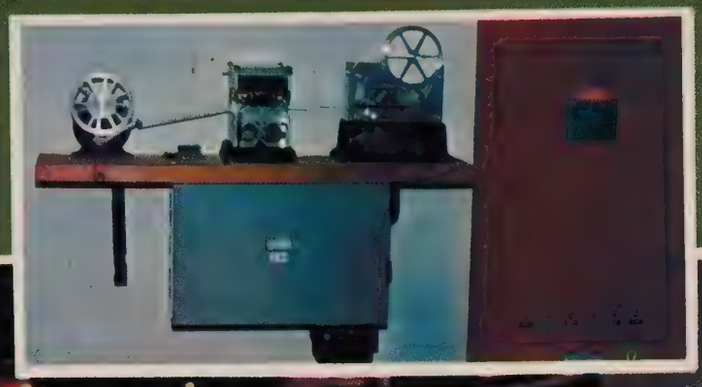
The selective transmission of alarms to fire stations is required by the National Fire Protection Association (Standard 73) when alarms handled by a fire department exceed 2,500 a year. That is, when the volume of alarms reaches that point, only those fire stations whose personnel are to respond to an incident should receive an alarm.

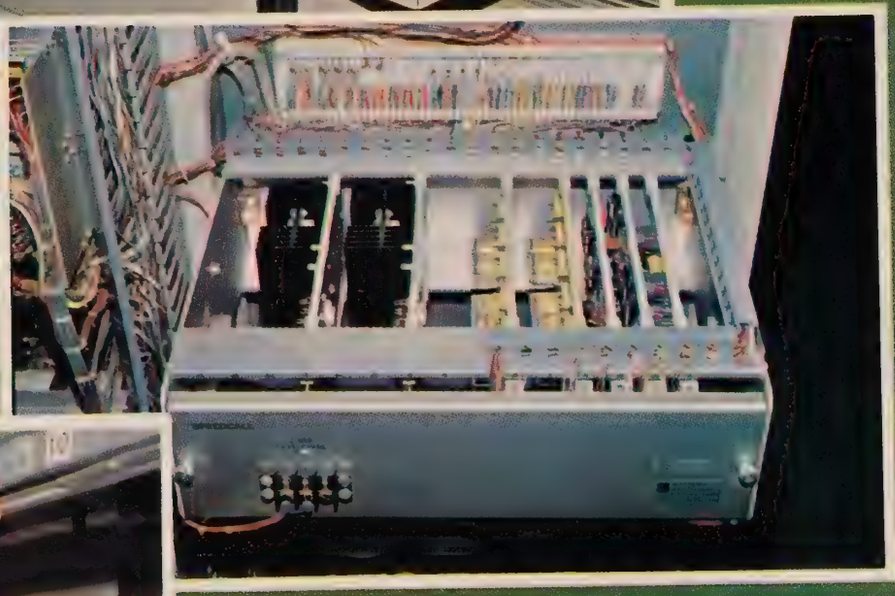
The NFPA refers to such an arrangement as a Type A or manual retransmission system. It usually consists of separate supervised wirelines to each fire station which are selected by a fire dispatcher manipulating key level switches at the central dispatch console.

Several years ago as Palo Alto's alarm volume approached that figure and plans to convert to a Type A system began to take shape, fire chief Bill Korff was disturbed by an obvious shortcoming of the conventional Type A arrangement. He had one fire station with four fire companies and one with three fire companies and a soon-to-be added paramedic unit. He did not want all personnel in those stations alerted for every single-engine alarm that might be received.

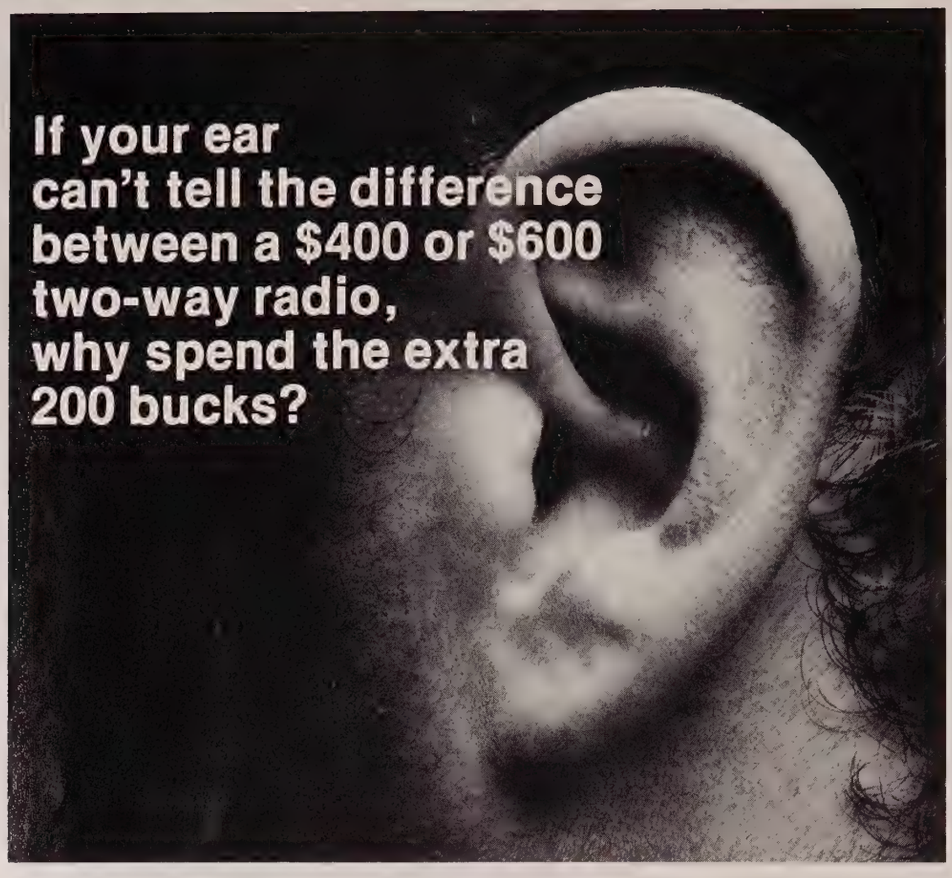
Conventional Type A techniques would not be acceptable. Nor could the conventional Type A arrangement be conveniently expanded to alert the individual fire companies at the multi-company stations. At the time Palo Alto had only five fire stations housing 11 fire companies, but the future held the possibility that the system might have to accommodate 10 more fire stations and 20 more fire companies if a regional communications center, then in early planning stages, came into being. A new system had to be devised — one which would provide ease and speed of operation and one which could be adapted to changing conditions. Any system to be used in the fire service would also have to meet all of the requirements of NFPA Standard 73. A functional specification was written around these criteria.

The signaling technique which appeared to best satisfy the functional specification was dual-tone





Facing Page: Golf course medical alarm box. **Above:** Jacqueline Gonzales and the Fire Selective Notification System encoder. The Fire Selective Notification System, which replaces older equipment **(Top)**, includes a remote control panel, pinboard matrix, and common base station unit.



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INFO/CARD 24

multi-frequency. A DTMF system could be arranged to meet all aspects of NFPA Standard 73. It is equally effective on wireline or radio circuits, has good signaling speed, is virtually free from falsing, and, for the communicator, is as easy to operate as a telephone.

We accordingly approached the Speedcall Corp., Hayward, California, with our functional specification and out of that the Speedcall model 7969 Selective Notification System was developed.

The model 7969 consists of an encoder, a common base station unit, remote receiving terminal, and remote control panel. The system provides selective signaling to the single-company fire station and to the individual fire companies at multi-company stations. Two audio paths, radio and wireline, are provided for voice communications. The signaling devices in the stations are single-stroke chimes. The old wind-up 10-inch gongs were replaced several years ago.

95 Codes Available

The encoder is a desk top console similar in appearance and size to a telephone instrument. It contains a DTMF matrix, a set of LED indicator lamps, a test switch, and a seven-segment LED display. Signal codes consist of three digits preceded by a pound (#) sign which clears the encoder of any previously entered signals. One hundred codes, less five used for test purposes, are available.

When a code is entered, it is registered on the seven-segment display to verify that the proper buttons were pushed. The encoder automatically keys the radio transmitter when the first digit is selected and an inter-digit timer keeps the transmitter keyed between digits. This times out 2.5 seconds after the last digit is sent.

The use of store and forward techniques would allow verification of the entered code before transmission and would ensure that the radio transmitter would be "up to speed" before the first tone would be entered. However, the added cost was not felt to be warranted and as long as the communicators hold the first tone for about half a second and do not pause more than two seconds between subsequent tones, performance is satisfactory.

One LED indicator lamp on the encoder is associated with each fire

station. This is used to provide alarm acknowledgement. When an alarm is sent to a station, the associated lamp is illuminated. The personnel at the fire station acknowledge receipt of the alarm and indicate that they are ready for dispatch by operating the "acknowledge" button at the station control panel and the lamp goes out. When all lamps at the encoder panel are out, the communicator makes a verbal dispatch. These lamps are also used for system testing.

The base station unit consists of a DTMF to BCD converter, LED display driver, loop check and lamp driver, line coupling transformers, and power supply. This unit drives the seven-segment and indicator LED displays at the encoder and provides audio and push-to-talk control simultaneously to radio and wireline circuits. The loop check circuitry provides an end-to-end check of the condition of the wireline to each fire station. The power supply is a DC-DC converter which drops the nominal 24 volts station power to 13.8 volts. Dual converters are provided with automatic changeover. Indication of a power supply fault will appear on one of the encoder LED lamps.

One Terminal Per Station

One remote receiving terminal is installed at each fire station. Each terminal has a wireline decoder, a radio decoder, two 20-watt amplifiers for radio and wireline audio, 10 function relays, radio and wireline muting relays, and a 500-position pinboard matrix for programming the terminal. By inserting a diode pin in the proper position, any of five alarm systems in the station can be made to respond to any received code.

The wireline and radio decoders are driven simultaneously so that a failure of either radio or wireline circuit will not affect operation of the system. The outputs of these decoders, in parallel, drive five function expanders, each of which accommodate 20 codes. The outputs of the function expanders operate the function relays through the programming pinboard matrix. Five of these relays are used to perform such functions as turning on station lights. The other five are driven through a pulser and operate the alerting chimes in various sections of the station. Facilities are thus available to selectively alert four fire com-

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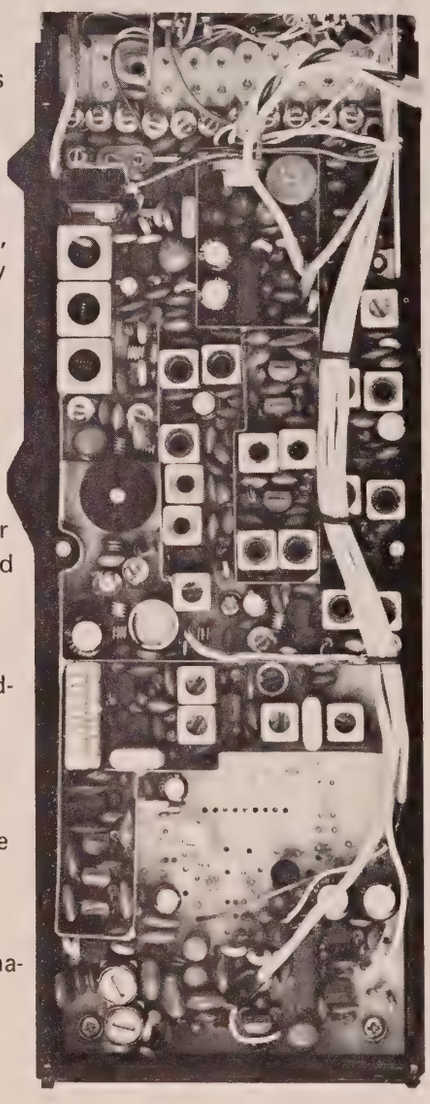

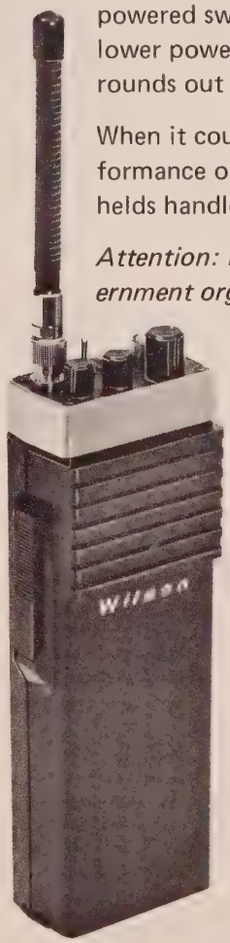

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8	33	58	83	108	133
9	34	59	84	109	134
10	35	60	85	110	135
11	36	61	86	111	136
12	37	62	87	112	137
13	38	63	88	113	138
14	39	64	89	114	139
15	40	65	90	115	140
16	41	66	91	116	141
17	42	67	92	117	142
18	43	68	93	118	143
19	44	69	94	119	144
20	45	70	95	120	145
21	46	71	96	121	146
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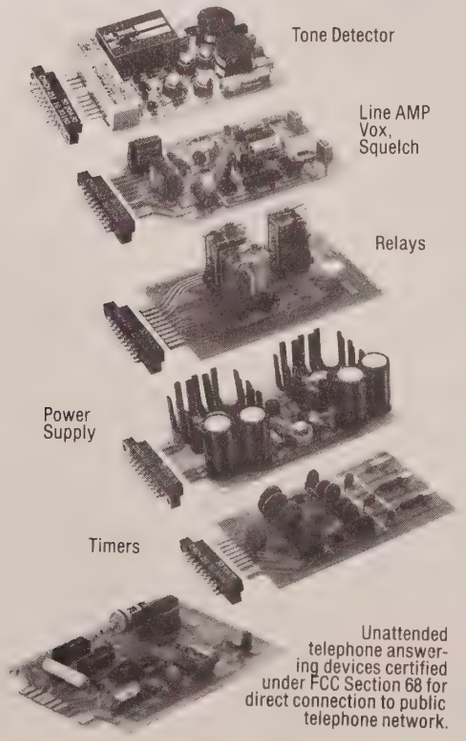

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panies at a station and still provide chime operation at common areas such as the apparatus floor and day room.

The radio and wireline amplifiers drive constant voltage audio lines so that speakers may be placed anywhere in the station and audio adjusted to suit conditions. At the smaller stations only two speakers are installed on the fire apparatus floor.

Control Panel Location

The control panel is located at a convenient place in the station usually on the apparatus floor. Five controls are provided. Two operate the radio and wireline audio relays, one resets the radio and wireline audio relays after either manual or coded signal selection, one is used to acknowledge alarms, and one is operated when the station is unmanned. The latter defeats the acknowledge lamp at the encoder console so that the communicator will not vainly wait for an acknowledgement which cannot be made because the firemen are out of the station.

The codes for each type of response are shown on the fire run cards. In making a dispatch, the communicator first clears the encoder with the pound (#) sign then enters the three-digit code. This unmutes the radio and wireline amplifiers in the selected stations and operates the alerting chimes for the responding fire companies. The encoder console indicator lamps for the selected stations are illuminated. When the members of a fire company are ready to receive the verbal dispatch message, they operate their acknowledge switch. This extinguishes the station lamp in the encoder console and tells the communicator that that fire company is ready to receive the dispatch message. When all lamps are out, the communicator transmits the message.

Operating the acknowledge switch causes two more things to happen — the pulsing of the alerting chimes ceases and the dormitory lights are extinguished.

Two Companies, Two Chimes

In some stations two fire companies occupy the same dormitory. In those cases, two chimes, each with an indicator lamp that flashes with the pulsing of the chime, are installed. If a com-

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INFO/CARD 10

pany's lamp does not flash when a alarm is received, the members of that company roll over and go back to sleep.

System testing, and considerable trouble diagnoses, can be done at the encoder console. A loop check function tests for wireline continuity. By using certain codes, the performance of the radio decoder, wireline decoder, and the function expanders at each station may be checked.

As originally designed, constant line supervision was not provided because of these handy and comprehensive testing facilities and because of the redundancy provided by the parallel radio circuit. This approach is not acceptable to the Insurance Service Organization so appropriate system modifications to provide supervision are being made.

The system has been in service for two years. Acceptance by the fire fighters has been enthusiastic. The communicators find it easy to operate and the technicians, after becoming familiar with the equipment, find it generally easy to service. □

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INFO/CARD 11

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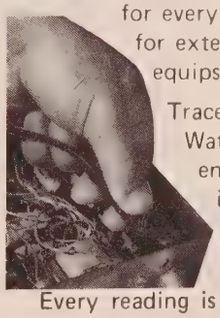

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INFO/CARD 28

Understanding DTMF Signaling: A Basic Technical Review

By Jack Daniel
Vega, Division of Cetec Corp.

Dual Tone Multiple Frequency (DTMF) signaling is based on the same type of signaling known by many as Touch-Tone™, which is Bell Telephone's trademark for DTMF signaling.

Many radio system designers are considering the use of DTMF signaling for individual unit signaling and/or interfacing into telephone systems. DTMF can provide valuable improvements to many customers *if* the system designer fully understands both capabilities and limitations of DTMF signaling, then uses equipment designed for that specific application. Customer satisfaction over choice of the signaling used is dependent upon use of the proper equipment as it was designed to operate.

The mobile radio environment is extremely more complex and demanding than a wireline telephone network from a technical viewpoint, and DTMF products designed primarily for telephone system use may result in poor operation or expensive modifications. Several manufacturers supply DTMF equipment for mobile radio use, and most decoders and encoders will work with other brands within the same system.

To understand DTMF signaling, let's look at the tone signals used.

Typical DTMF Signaling Train Breakdown: Example Number is "5548"

In the example shown in Figure 1, "number of digits" is four (5, 5, 4 and 8).

Timing: (Based on manual encoding)
Digits — 50 milliseconds to ≈ 1 second duration.
Interdigit Pause — 30 milliseconds to ≈2 seconds duration.
End of Number — No valid input for over ≈ 2 seconds.

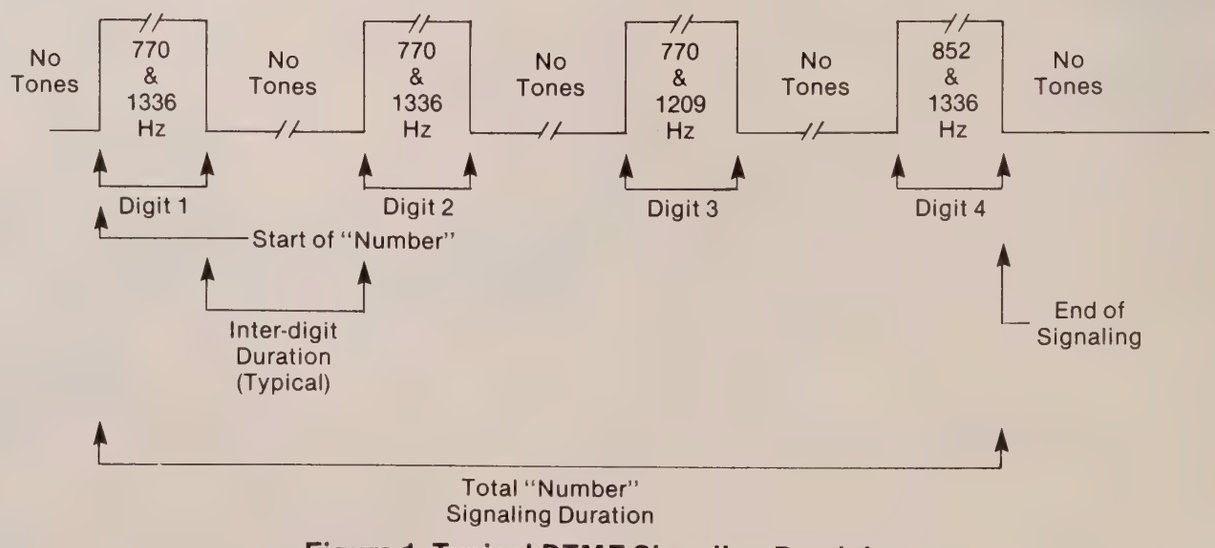


Figure 1. Typical DTMF Signaling Breakdown

Note: Minimum duration (fastest "manual" encoding) is normally based on 10 digits per second and 50:50 ratio between digits and approximately interdigit periods. This results in approximately 50 milliseconds duration for both the digits and interdigit timing.

Frequencies are "grouped" as follows:

697, 770, 852 and 941 Hz = "low group"
1209, 1336 and 1477 Hz = "high group"

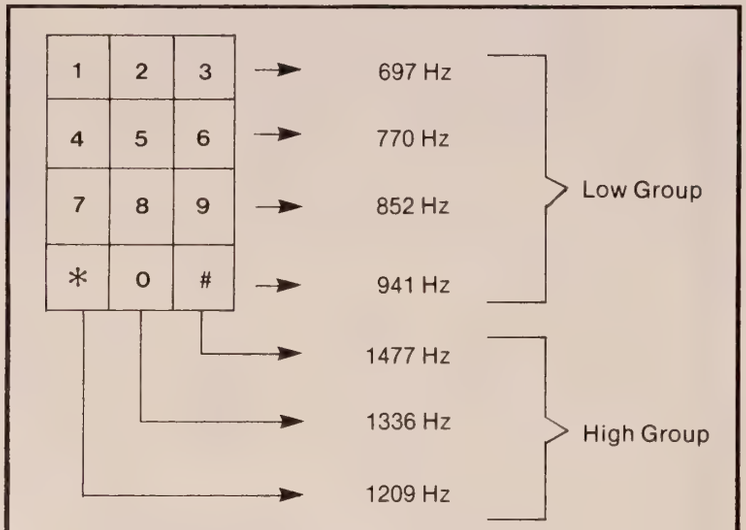
DIGIT	TONE	FREQUENCIES
0	941 and	1336 Hz
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
#	941	1477
	(Low Group)	(High Group)

Two-Tones are used simultaneously for each digit.

"2 of 7" coding scheme (two-tones out of seven frequencies).

Frequencies Used in DTMF

Note: All digits are derived from combinations of one low group and one high group tone frequency for any single digit.



Key Pad — Tone Matrix Chart

Other DTMF Terminology:

"Twist" refers to the differences in amplitude between a high group tone and a low group tone as a result of the audio frequency response of the tone and path circuits. Ideally, there is no difference (zero twist), but in radio systems there can be 10 dB or more twist due to the pre-emphasis and de-emphasis circuits of the radios. Since this varies from model to model, a high degree of twist tolerance

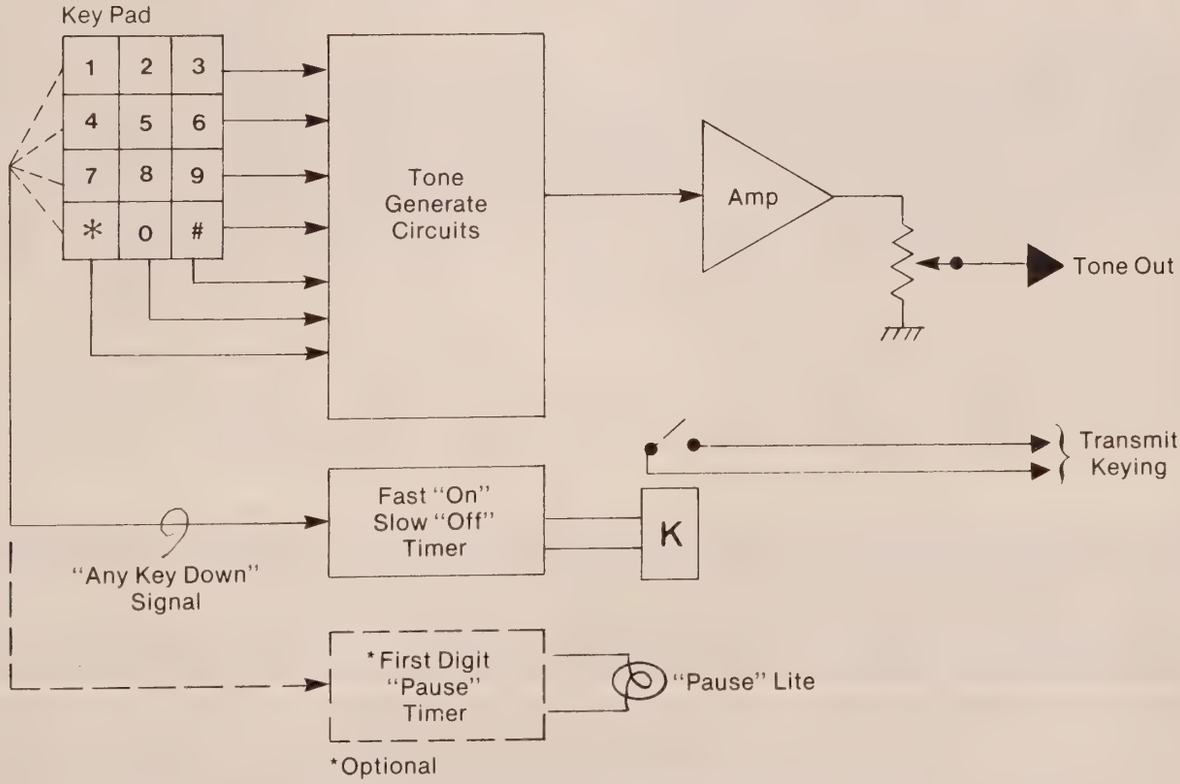


Figure 2. Typical Manual Encoder Circuit

is desirable in the decorder specifications.

"Skew" is telephone company language for frequency shift of the tones. In two-way radio, it is relative to the tone frequency bandpass acceptance of the decoder. This would be wide enough to tolerate tone frequency changes as a result of temperature, voltage variations, etc., of both the encoders and decoders used.

DTMF Encoders

At first glance, one might think the encoder is simply the tone assembly out of a Touch-Tone™ telephone: It generates the right frequencies, is readily available and it is cheap. However, there are added requirements in mobile radio applications. In most cases, the standard telephone tone dial could only be used as *part* of a two-way radio encoder. Three major factors in two-way radio use are: 1) You have to key the transmitter and hold it keyed during interdigit periods; 2) You must be able to adjust the tone (modulation) level; and 3) You must operate from a vehicle's widely varying supply voltage.

Other features may include a "pause" light which assures that the first digit has been on long enough for the transmitters and receivers of the system to be turned on. In mobile repeater systems, the start up delay may totally eliminate reception of a fast first digit. Lighted dials may be desirable, although they increase the DC current demands and encoder costs.

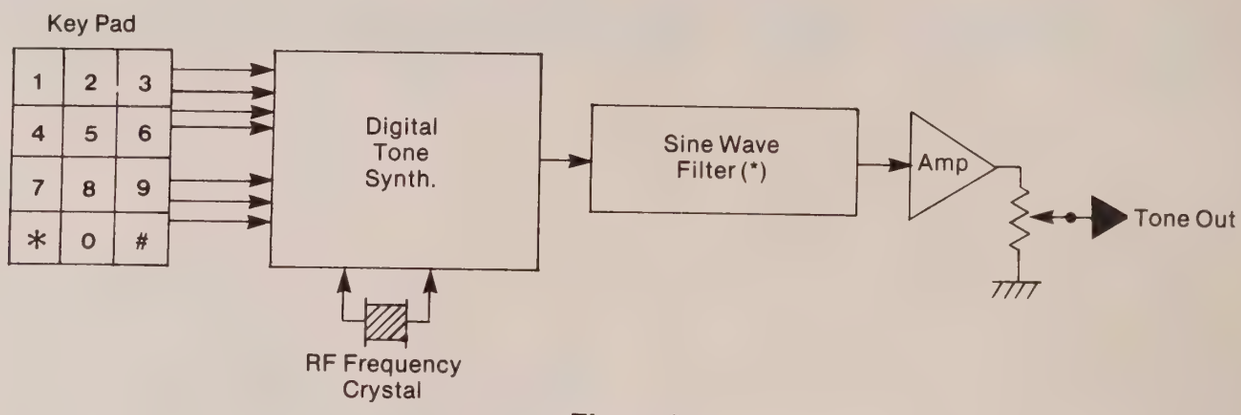


Figure 3.

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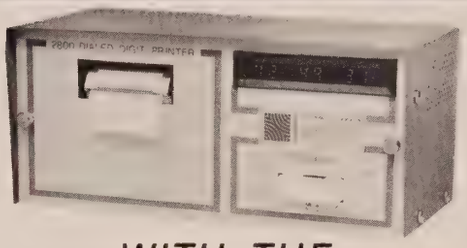

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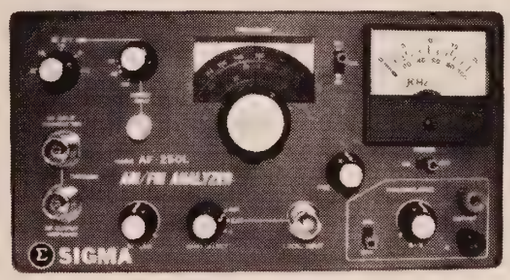

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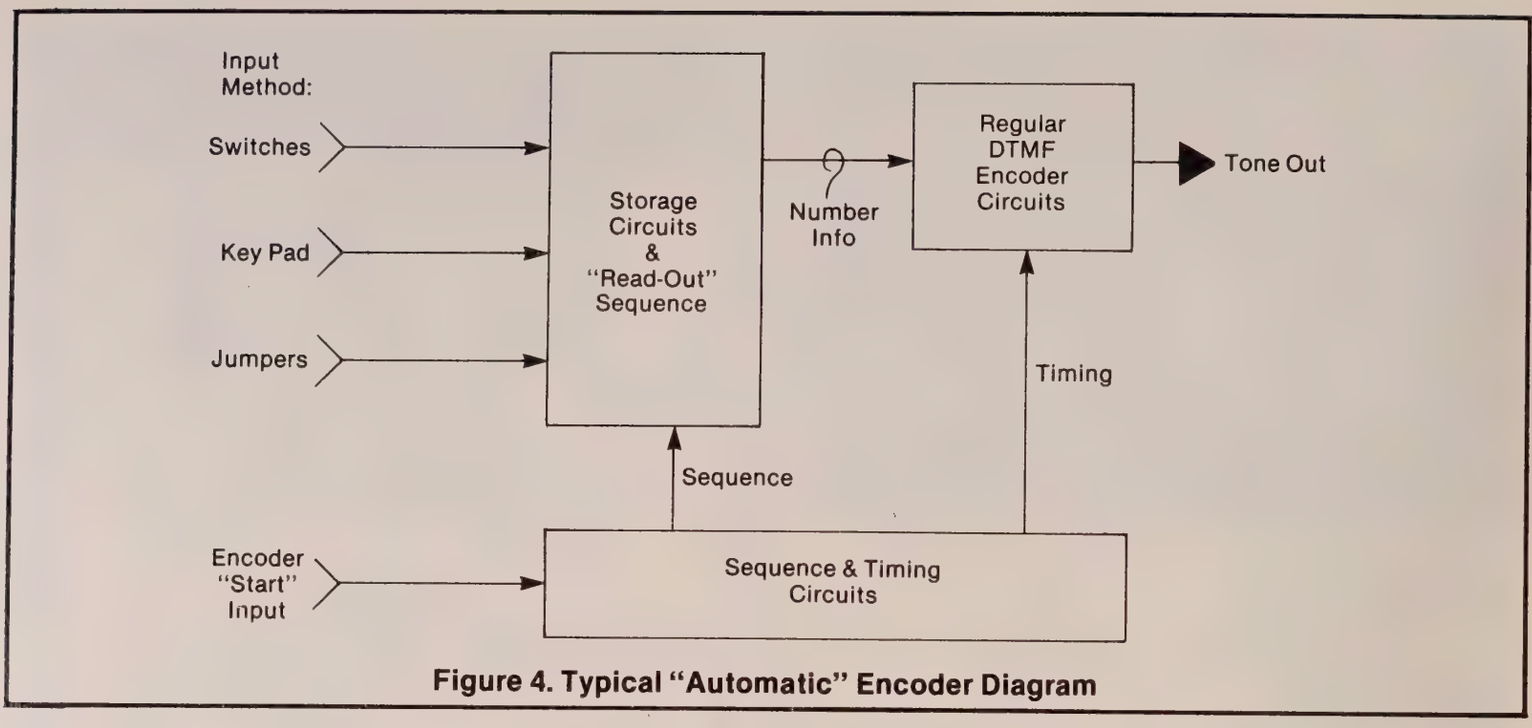


Figure 4. Typical "Automatic" Encoder Diagram

Typical Manual Encoder Circuit

Very recently, integrated circuits have been introduced which digitally derive the DTMF frequencies from a crystal-controlled time base (Figure 2). These are accurate in frequency and stable over wide temperature ranges. When these are used, the block diagram changes slightly (Figure 3).

In some types, the high group and low group tones are separate and two sine wave filters may be used. Note: Timing circuits are the same as in the preceding drawing.

The crystal oscillators in this type are most frequently at 1.0 or 3.58 MHz. The RF radiation is not normally a problem to nearby receivers due to the frequencies, low levels and the assembly methods (suppression) used by most manufacturers. However, don't forget the possibility in "strange" interference complaint cases.

"Automatic" DTMF Encoders

These types generate tones in the same manner as the manual encoders. The primary difference is in how the digit inputs are handled.

The digits of the desired number may be entered from a standard key pad, rotary switches or, when the number isn't changed by the radio operator, by internal jumpers or "coding pins". All these inputs are "stored" in the encoder until the input is complete and a specific command is given to the encoder to transmit.

When an automatic encoder is used, the digit tone duration, interdigit durations and other timing is controlled by the encoder circuit rather than the operator. This results in transmitting a nearly perfect DTMF number and increases both the reliability and speed, overall. Additionally, operator error is reduced greatly.

Automatic Number Identification (ANI) Encoders

This is a form of automatic encoding which includes an internally coded DTMF number. Encoding is usually initiated by some non-operator-controlled radio function, such as taking the microphone off hook or keying the transmitter.

The primary use of the ANI encoder is to signal into an ANI decoder-display receiver which will identify, by the number shown, which transmitter or mobile is on the air.

In some types, the automatic encoder includes both ANI and operator-controlled functions. The operator-controlled functions are usually "status" type number identifiers. This combination then provides the decoder-display with both transmitter identification and one of many possible

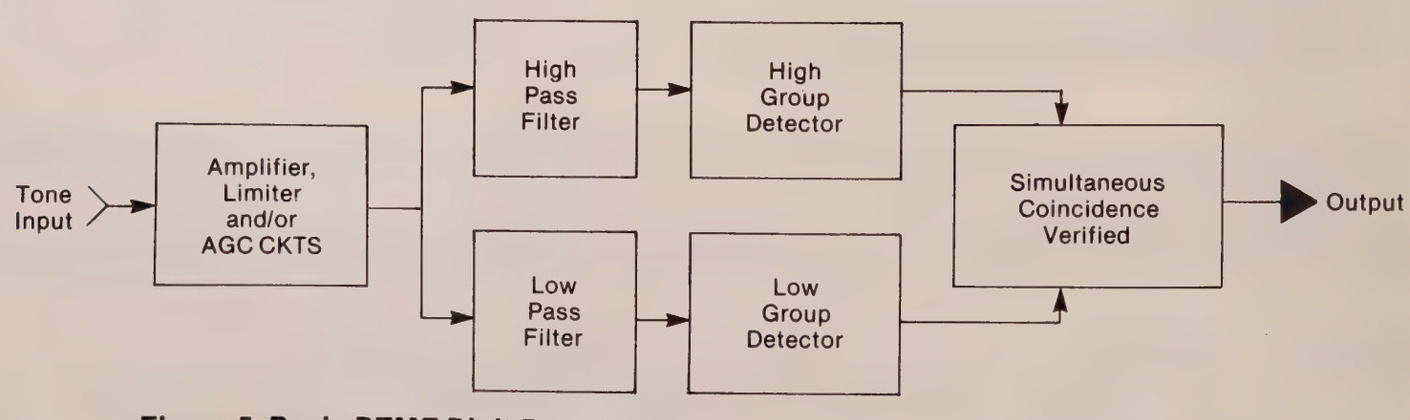


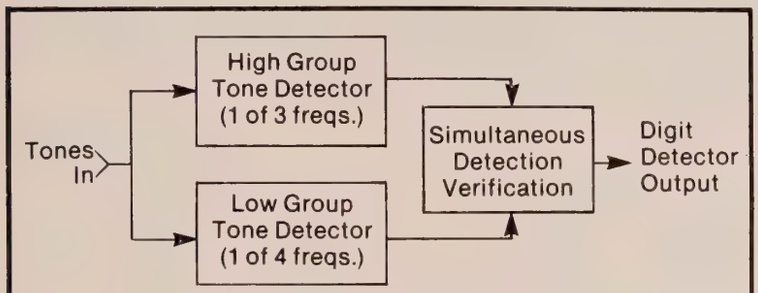
Figure 5. Basic DTMF Digit Decoder Diagram with Common Audio Pre-Processing

status (coded messages) combinations, eliminating the need for spoken messages in many situations.

DTMF Decoders

DTMF decoders come in many configurations, each being designed for a particular application.

In order to understand the total decoder, it is best to follow the evolution starting with the basic one digit (simultaneous two-tone) detection.



Basic DTMF Digit Detector

This detector is not unlike having two commonly used single tone detectors with a common input circuit plus an "and" circuit connected to the two outputs to assure both decoders have outputs simultaneously. This provides an output corresponding to only one *digit* of the DTMF code scheme.

The block diagrams of the tone detectors are over-simplified, as each represents several circuits to accomplish reliable tone detection. Each one incorporate circuits for audio amplification, audio level stabilization (limiters, AGC, etc.) plus a frequency detector. Since these functions of audio processing are common to both the high group and low group of frequencies, it is economical to place one of these circuits in the audio path before two or more tone detector inputs. This is shown below.

Basic DTMF 1 of 12 Digit Decoder Diagram

Taking the techniques used for single digit detection, the circuit is expanded to give individual outputs repre-

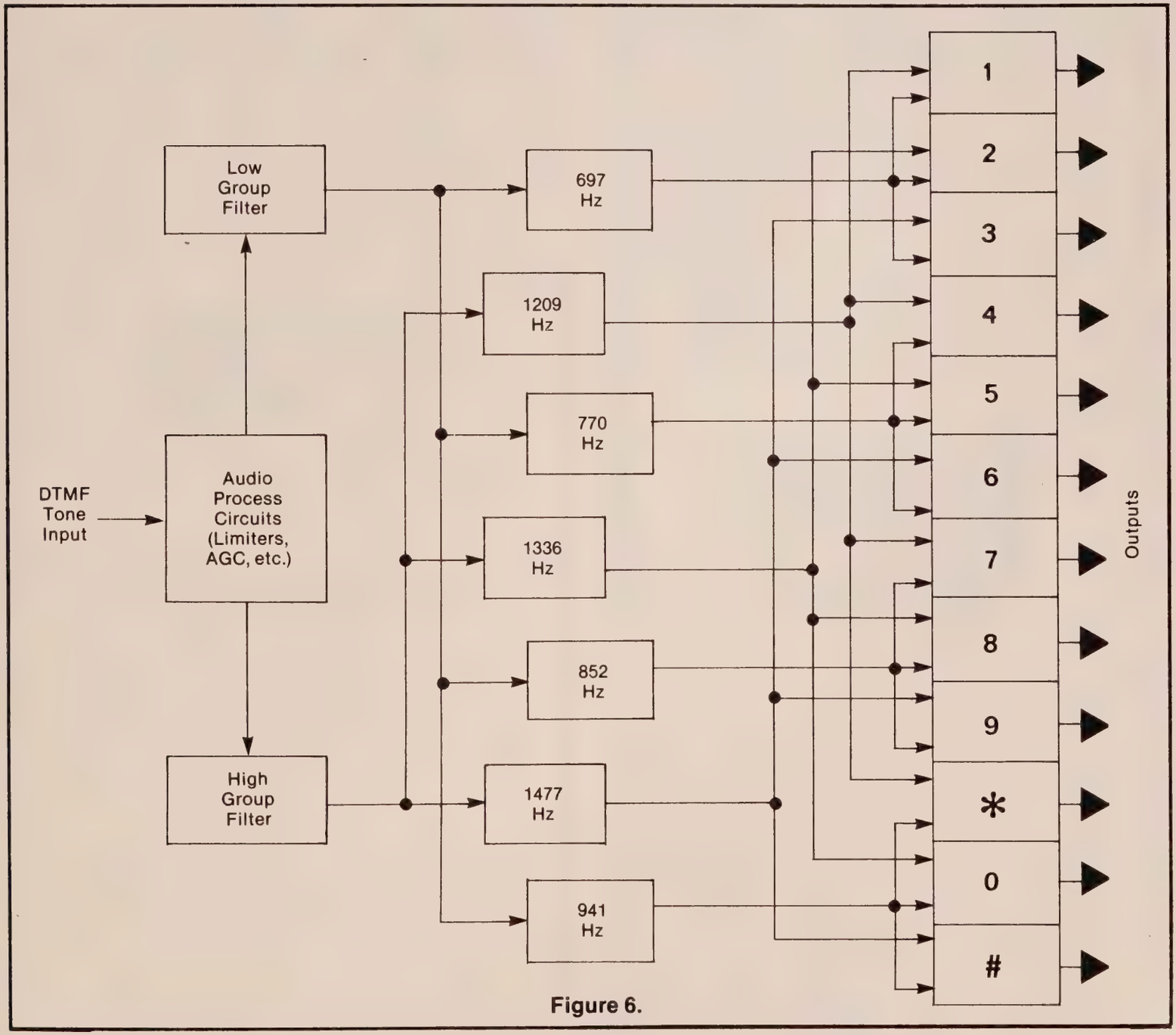


Figure 6.

senting the DTMF *digit* being detected (Figure 6).

Normally, this decoder by itself is not useful in two-way radio. It only provides 12 possible outputs and additional circuitry is required to decode a multi-digit number. The immunity from false decoding is also very poor when compared to a multi-digit number type approach.

Most two-way system designs use DTMF signaling for the purpose of individual mobile unit or station selection (calling). The number of units equipped with individual selection decoders varies, but requirements for over 20 individual decoder selection capability are normal. It is also sometimes desirable to use some form of a number assignment plan to simplify the customers' operational use of the signaling system.

The result is that most decoders must accommodate a single multi-digit, pre-assigned individual number. In other words, mobile unit number 5548 is called by simply encoding "5548" and then that unit (and *only* that unit) responds. This is commonly called a "dedicated address" decoder.

If a 1 of 12 decoder (with the additional circuitry required to determine the proper multiple digit number) was

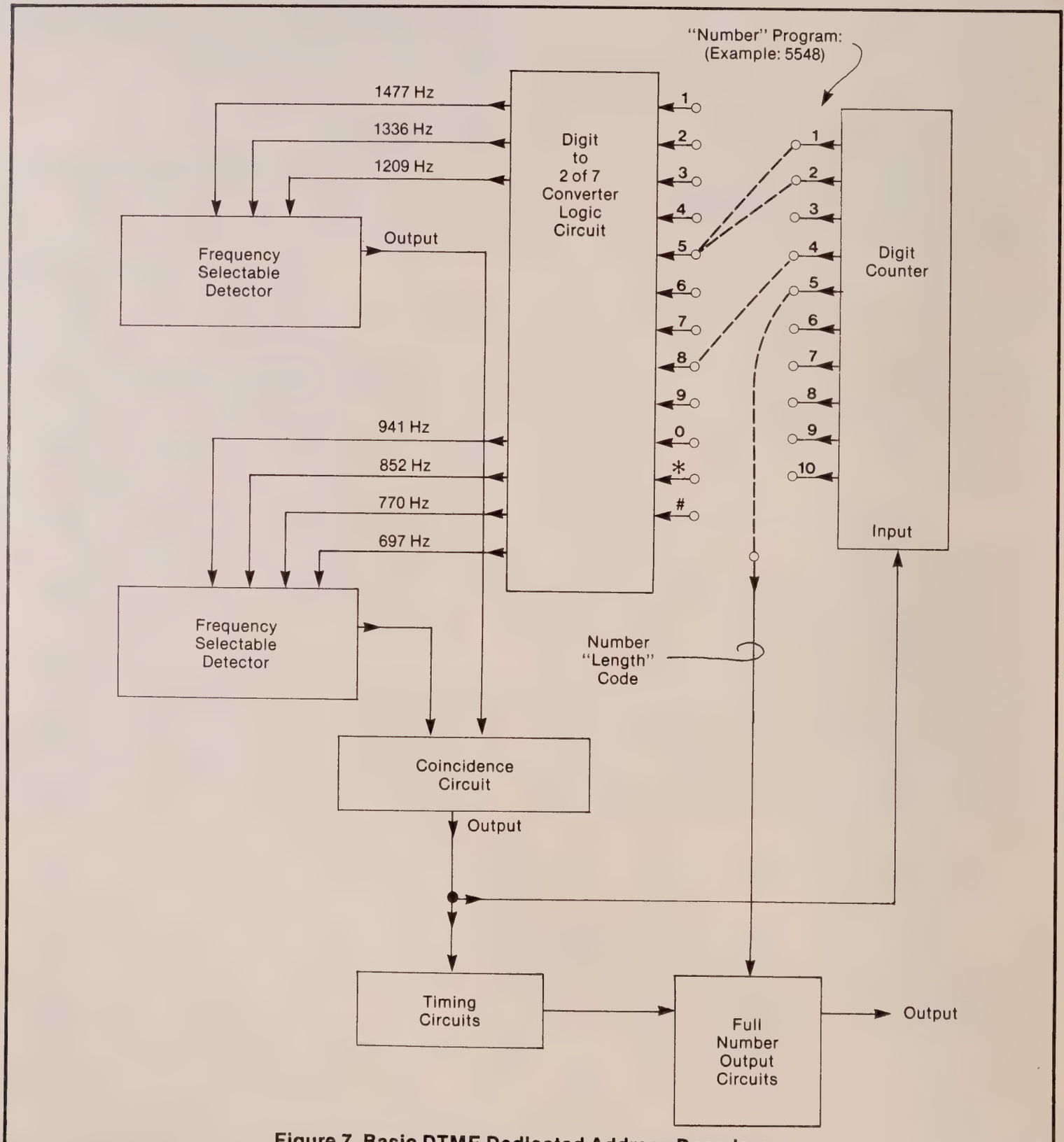


Figure 7. Basic DTMF Dedicated Address Decoders

used as a dedicated address/individual call-type decoder, the cost would be very high due to the amount of components required. Fortunately, for both you and the customer, there is a much simpler and inexpensive way to achieve the individual call, multi-digit decoder function.

Basic DTMF Dedicated Address Decoder

In the circuit shown in Figure 7, the fact that the individual number to be decoded and the DTMF signal train characteristics are predetermined eliminates a large amount of circuitry which would otherwise be required.

Tone Detection

The key factor is that only one DTMF digit detection is required at any point in time, therefore only two tone detectors are required at any one time. To accomplish multiple digit decoding, we must use tone decoders which can decode three and four selectable frequencies for the high tone group and the low tone group, respectively.

In our example number "5548", we must switch the high group decoder to detect 1336 Hz for the first two digits, then to 1209 for the third digit and then back to 1336 for the fourth and final digit. The low group decoder would be set for 770 Hz for the first, second and third digits and switch to 852 Hz for the fourth digit.

The combination of switching the detection frequencies of the high group and low group detectors, at the proper time, gives us the four digit number decoding of "5548" and that four-digit number only.

Timing (Interdigit Condition)

In order to switch these decoder frequencies at the proper time, the decoder must establish the "interdigit" point. This point in time signals us to advance to the next number to be decoded.

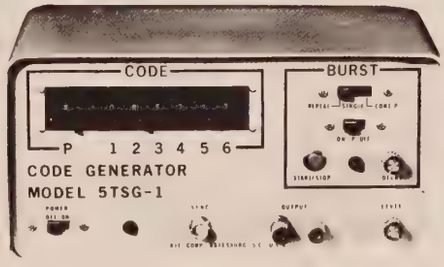
We also must know when the last digit has been sent so that the decoder can either provide an output (if the proper number was decoded) and to reset the frequency switching counter. Keep in mind that if the frequency switching sequence (digit counter) is not reset, the decoder will not respond to the proper number which may be sent after other numbers have been sent in the radio system.

These two time periods are determined in various ways by different manufacturers. The most positive method of determining the interdigit condition is to detect an absence of the last number sent for a period of several milliseconds. This time must be long enough to *not* accept quick signal fades (which happens in moving vehicles) and short enough to anticipate fast digit sequences that an experienced encoder operator may send.

The end of number is determined by the length of time after the final digit of the number is sent. This time must be longer than the *interdigit* time of a slow encoding operator or it will reset the decoder prematurely.

Programming the Decoder

In order to be on the right detection frequencies at the right time, the decoder must be "programmed" to use the timing and detector output information in the proper sequence.



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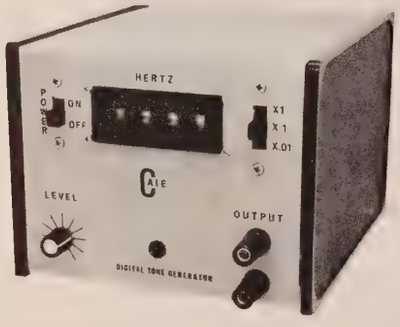

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The digit sequence steps can be established relatively easily by using the interdigit timer to advance a conventional digital counter circuit. The "digit" counter is reset by the "end of number" timer. The digit counter outputs will then advance one at a time in the proper sequence. The digit counter outputs are then connected to the decoder frequency selection circuits.

At this interconnection is the "programming" which causes a predetermined digit to be detected in the proper position within the digit sequence. This is usually an arrangement of push-on pins or jumpers which permits easy field changes of the number by a technician.

To further aid the person programming the decoder, the frequency selection inputs are usually arranged in a plain language digit designator manner (i.e., "1, 2, etc."). This eliminates multiple jumpers and any confusion that could arise if the two tone frequencies required for each digit were individually programmed.

Number Length

The number of digits in the number is also normally programmed in this type of decoder. Number lengths of 2 to 10 digits are common practice. As an example, our "5548" number is a four-digit number and this would be programmed inside the decoder as per the manufacturers' instructions. The reason for number length programming is to determine the "end of number" condition when a valid number is received and promptly enable the output without the long timing delays required otherwise.

Limitations of Dedicated Address Decoders

The preceding discussion shows that this type decoder is the best choice, especially economically, for individual unit selection. However, the dedicated address does have two basic limitations which could cause system operation problems if they are not anticipated in your system design:

A) A dedicated address decoder cannot accept "multiple addresses". A multiple address requirement would be to provide one or more decoder outputs for more than one distinct number, such as "5548" and "5549", only *one* output derived from *one* number can be obtained. Should your system have this requirement, other specialized type decoders are available.

B) A common system design oversight is that fact that this type decoder will accept (and decode) any DTMF number which contains the digits for which it is programmed, if they occur in the same sequence.

As an example, a system is configured where Touch-Tone™ telephone numbers will be dialed over the same channel that the decoders are signaled. Our decoder, programmed to decode the DTMF number "5548", will also decode on the telephone numbers of 345-5480 or 455-4835, etc.

The only economical way to avoid this situation is to assign codes for the decoders which will not correspond to any other DTMF sequence. Several code schemes accomplish this:

A) Simply make the decoders' code numbers at least one digit longer than the invalid DTMF numbers. This is

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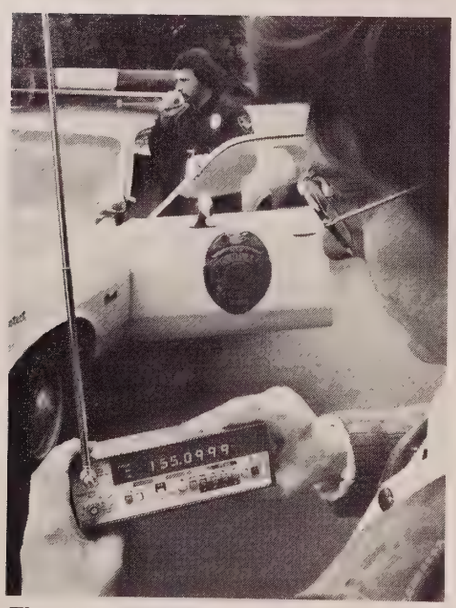

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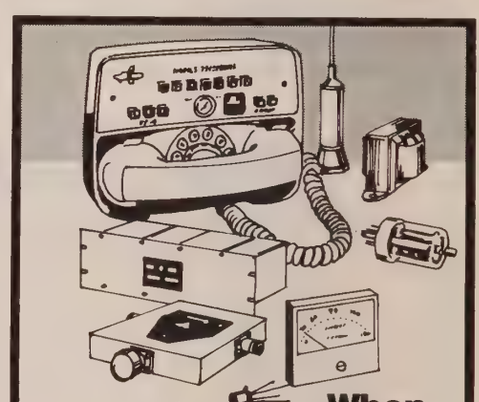

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not usually the best approach, because the radio users must remember much more complex numbers and the possibility of dialing errors is increased.

B) Assign decoder *numbers* which will never appear in the same sequence as the invalid DTMF numbers. The local telephone numbers are always made up of consistent three-digit "exchange" numbers. As an example, the exchange numbers are "345-XXXX" and "455-XXXX". By starting each decoder code with three non-related digits, such as 222XX, 221XX, etc., and using five digits, there will be no common combinations. This method still requires many digits to be encoded and is subject to false number decoding if the telephone numbers either change numbers or increase in the number of digits (such as in long distance dialing).

C) Assign decoder *digits* which do not occur in the invalid DTMF numbers. By using the * or # in the decoder number, no regular telephone number will be invalidly decoded. As examples: * 345 or 123 #.

General Mobile Radio "Considerations"

Mobile radio signal considerations are much more complex than those found in telephone line signaling. Since most problems are a result of the signal path, most solutions are found in the decoders. In a telephone system, the audio levels and quality are more predictable and controlled than in most two-way radio systems. Radio systems have the following variations:

Tone Level: Varies from radio to radio, according to modulation levels, pre-emphasis and de-emphasis curves, point of decoder input connection, etc.

Tone "Twist": This condition is much worse in radio systems than ever encountered in a telephone system.

Tones (or audio) present at same time as signaling: In telephone systems, only the "dial tone" appears and only during the first digit encoding. All other interfering sources are minimal. In mobile radio it is not uncommon to have subaudible tones, ignition noise, power supply hum and whine, etc. present with the tone. Add to this the noise of a disquieting RF signal level and occasionally an open microphone. It is important that the decoder be immune to non-DTMF tones, especially CTCSS tones.

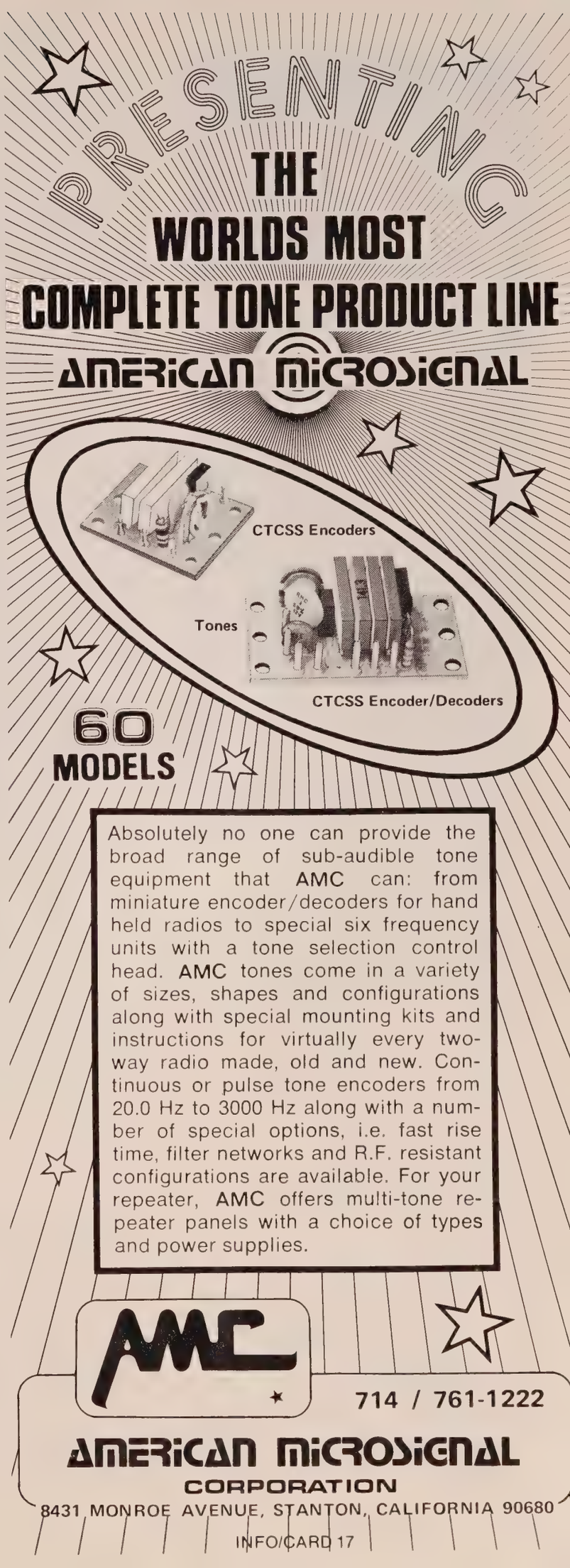
Tone Interruptions

This almost never occurs in a telephone system. In a radio system, it may occur frequently. A condition called "Double Digiting" occurs, as an example, when a digit is being manually sent from a mobile unit and during the digit the radio signal reception is momentarily interrupted due to a multipath fade (going through an underpass, etc.). As far as the decoder is concerned, that digit has appeared at the input twice, due to the RF fade looking like an interdigit pause.

This can be minimized in a decoder which has timing circuits that ignore very short interruptions in the tone.

Summary

The author recognizes that DTMF products and applications include many details not covered in this brief article, but this information should serve as an introduction and a better understanding of more specific situations. □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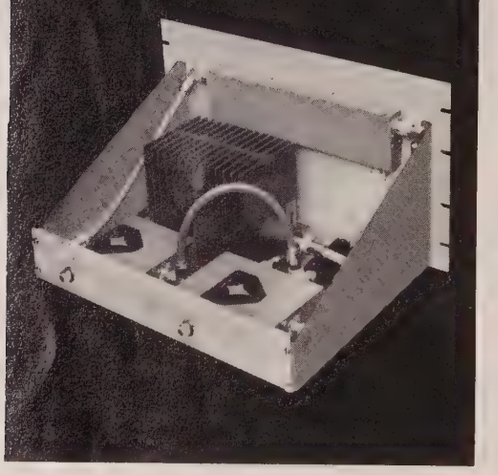

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Transmitter Monitor: Spectrum Specialties, Inc.

A new transmitter monitor that simultaneously measures carrier frequency and either AM or FM modulation "off the air" has been introduced by Spectrum Specialties, Inc. The model 1000 contains a versatile 7-digit counter that operates in 3 modes.

It 1) Measures carrier frequencies "off the air", tunable from 20 MHz to 1000 MHz with 2 uv sensitivity and 100 Hz resolution; 2) Measures tone frequencies on "off the

air" carriers with resolution to 0.1 Hz; 3) Serves as a general purpose counter from 50 Hz to 520 MHz with 20 mv sensitivity.

Phase locked circuitry and 1 ppm/yr TCXO time base insures stable and accurate transmitter measurements. Large rectangular CRT display provides instantaneous and accurate (2 percent) AM or FM modulation measurements.

Wide band scope circuitry allows viewing of signals from 1 Hz to 200 KHz, and built-in speaker provides simultaneous aural monitoring.

Telephone trouble-shooting and plug-in PC board exchange program under 3-year warranty provide ease of servicing and continued product support.

Introductory price is $2,750. Contact SSI at 1375 Lennox Way, Sunnyvale, Calif. 94087. INFO/CARD 100.

Indoor FM Antenna: British Industries Co.

British Industries Co., Division of Avnet, Inc., has introduced a unique indoor FM antenna which it calls "The Beam Box".

The Beam Box is a new type of high fidelity component, specially designed to be permanently positioned alongside, above, or beneath the other components in a music system.

The Beam Box is equipped with a passive electronic circuit that directs its sensitivity pattern towards any one of four geographic quadrants at the turn of a switch, without the antenna itself ever having to move. Unlike a wire dipole, it is able to receive optimum signals from any direction. By electronically directing its reception pattern towards the signals desired, multipath signals are suppressed.

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Rugged metal case insures greater RFI immunity while single universal cable allows interconnection to all major makes of radio systems. Unit also includes built-in dry relay contacts for push-to-talk keying. The Challenger ME-0705 mobile encoder. Reliability at your finger tips! See your local Challenger rep for complete specs, or write manufacturer direct:

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proximately sixteen times more responsive to the desired signal than to other frequencies on the FM band. The results: improved image rejection, I-F rejections, spurious response rejection and reduced interference from unwanted signals in or outside the FM frequency band.

The Beam Box uses no house or battery current. It carries a suggested retail price of $89.95. Contact B.I.C. in Westbury, N.Y. 11590. INFO/CARD 101.

Full Duplex Radios: Redicom/Kokusai

A new line of VHF and UHF duplex radios with cables compatible for most RCC and telephone heads has been announced by Redicom of Lawndale, California. Both UHF and VHF models offer in excess of 20 watts output power and exceptional 0.35 uV/20 dB receiver sensitivity.

The compact power unit fits neatly in any automobile trunk or behind the seat of most commercial vehicles, Redicom says. Cables offered are easily connected to many popular telephone control heads with no added adaptors, making a low cost "turn-key" installation available at low prices.

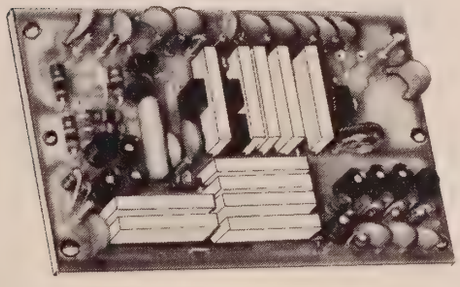
Contact Redicom, at 5422 W. Rosecrans Ave., Lawndale, Calif. 90260. Circle INFO/CARD 102.

Encoder/Decoder: American Microsignal

American Microsignal Corp. is offering its newest single or multi-frequency sub-audible tone encoder/decoder, model 592.

The unit is available in three configurations: the 592B for direct retrofit in Motorola Motrac, Mocom and Micor radios; the 592D for General Electric Mastr Pro, Executive and Royal radios; and the 592F for use in RCA radios.

The AMC unit is completely compatible



with all of these Motorola, GE and RCA sub-audible tone systems, and is available in either standard or special frequencies from 20.0 Hz to 250.0 Hz.

Provision has been made to accommodate up to 6 tone frequencies which may be electronically switched if required. Capability for automatic revert for common encode or common decode configuration can be provided from the factory or added in the field. Complete step by step instructions are provided in a comprehensive installation and service manual.

Applications engineering assistance is available. Contact American Microsignal Corp., 8431 Monroe Ave., Stanton, Calif. 90680. INFO/CARD 103.

800 MHz Maxar Radio: Motorola, Inc.

Motorola's economical Maxar FM two-way mobile/control station radios are now being offered in the 800 MHz band.

Standard features on the 800 MHz Maxar

radio include the enhanced performance and reliability resulting from integrated and hybrid circuitry, monolithic crystal and harmonic filters, and a solid-state antenna switch.

The entire radio, including speaker, is housed in a small (2 3/8" H x 6 5/8" W x 11" L) package weighing 6 pounds. Popular options for this dash-mount radio include such items as locking trunnion, two-frequency operation, Digital Private-Line Coded Squelch, and Quick-Call II signaling.

Contact Motorola Literature Distribution Center, 1301 E. Algonquin Rd., Schaumburg, Ill. 60196. INFO/CARD 104.

Touch-Tone™ Encoder: General Communications

The TT150M. mobile Touch Tone™ encoder (dial) is now in production at Gen-

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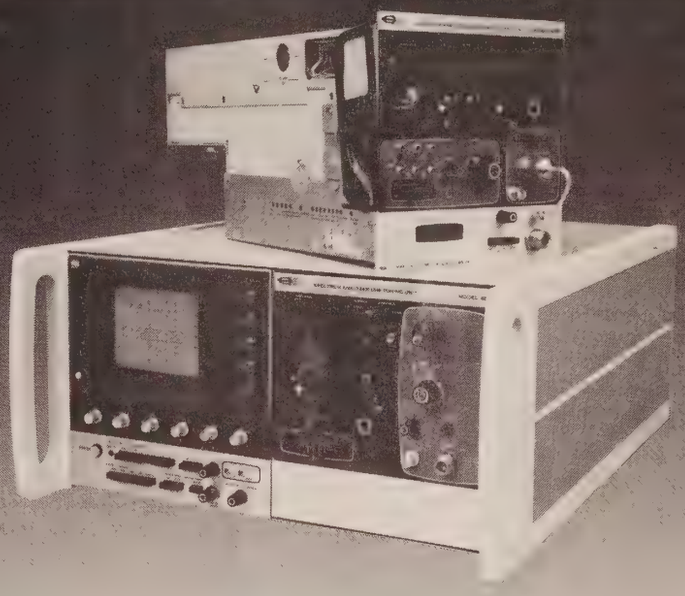


with two easy plug-in's 10 KHz to 40 GHz

With the introduction of the Model 4808 UHF Tuning Unit, Systron-Donner spectrum analyzers have been expanded to include low frequency coverage.

Key features of the Model 4808 include • Tuning range 10 KHz to 1.8 GHz • −120 dBm sensitivity • 100 Hz to 1 MHz resolution band width • Absolute amplitude calibration • Automatic phase lock • Digital frequency read out • Frequency tuning center or start of sweep • Built-in calibration signal.

Thanks to the modular design of S-D's spectrum analyzer system, the Model 4808 10 KHz to 1.8 GHz UHF Tuning Unit can be interchanged in a matter of seconds with the 10 MHz to 40 GHz Microwave Tuning Unit (Model 4809A.)

For complete details on the industry's most versatile and easy-to-use spectrum analyzer, contact Systron-Donner, Microwave Division, 14844 Oxnard Street, Van Nuys, California 91409. Phone (213) 786-1760.

SYSTRON DONNER

INFO/CARD 46

eral Communications Manufacturing in Omaha, Nebraska. A complete departure from the conventional Touch Tone mobile encoder, its small size (3-1/4" by 2-9/16" by 1-1/4") allows for versatile mounting in most vehicles.

An automatic keying circuit keys the transmitter upon selection of the first digit. The transmitter then remains keyed until 2 1/2 seconds after the last digit is dialed. Computer-type elastomer switches are particularly suited to a mobile or base station installation where dust and vibration are a problem.

This encoder has the standard Touch Tone 12 digits, but for special applications, the 16-digit model is available. This, along with all other General Communications-manufactured accessories, carries a standard one-year warranty for parts and labor. For more information, contact General at 827 South 20th St., Omaha, Neb. INFO/CARD 105.

UHF Hand-Held: Wilson Electronics Corp.

The high-powered Wilson T-4604 MX 4-watt unit has been designed to provide power, performance and economy. The unit is in the 450 to 475 MHz range, and produces switchable 1 and 4 watts output.

Powered by a rechargeable Nicad battery pack, the T-4604 MX will give a full day's operation. The unit has 500 milliwatts of audio power, six helical resonators and uses a durable Lexan^{R} outer case. Most popular tone options are available.

The T-4604 MX weighs 20 ounces, less batteries, and carries up to 6 channels.

Contact Wilson Electronics Corp., Commerical Products Division, P.O. Box 19000, Las Vegas, Nev. 89119. INFO/CARD 106.

Touch Pad Dialer: CES, Inc.

New touch pad dialer (model 400) replaces rotary dials in all mobile telephone control heads. The unit, manufactured by Communications Electronics Specialties, Inc., features a crystal-controlled MOS integrated circuit for high accuracy and stability.

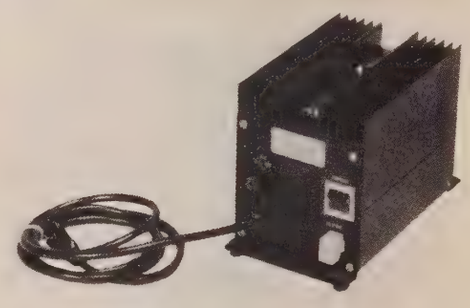
Also featured is automatic redial of the last number dialed. The dialer is compatible with all control heads since relay contacts are used to replace the rotary dial contacts. The unit comes complete with face plate and mounting hardware.

Contact CES, Inc., at 399 W. Fairbanks Ave., Winter Park., Fla. 32789. Please circle INFO/CARD 107.

Power Converters: Newport Engineering

Newport Marine Engineering, manufacturers of Newmar shipboard and base station power converters, announces the addition of two new models to their marine and land mobile family. A new light duty 25-watt, 5-amp VHF power supply, and a new heavy duty 25-watt, 8-amp unit have been announced.

The smaller model 115-12-5 is a low-cost shipboard supply designed for light duty VHFs and other intermittent loads. The larger model 115-12-8 is a more rugged



converter and provides 8 amps DC for commercial type synthesized VHFs.

Contact Newmar, P.O. Box 1306, Newport Beach, Calif. 92663. INFO/CARD 108.

Antenna Connector: Turner Div. of Conrac

Turner Division of Conrac Corp. has announced that a patent is pending on a product development that provides a new answer to an old antenna installation problem. Company officials said that the new method of connecting the cable to the antenna has been in production for several months now. The new screw-in antenna connectors, as well as the radio con-

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nectors, are being attached at the factory, which means that field soldering is no longer necessary. An added benefit is simpler field repair or replacement because the mount can be removed without removing the entire cable system, Turner says.

The connector at the antenna end is less than 3/8" wide, allowing easy access to even the smallest roof mount holes. The coax cable is simply screwed into the antenna mount. The connector then makes a firm contact with Turner's spring-loaded coil-to-cable contact. The trunk or roof mount is then secured and installation is completed by plugging in the factory installed radio connector. Contact Turner, at 716 Oakland Rd. N.E., Cedar Rapids, Iowa 52402. INFO/CARD 109.

Antenna Rod Cutter: Larsen Electronics

To simplify rod cutting for mobile antenna installers, Larsen Electronics has now introduced an antenna rod cutter that gets the job done faster. With long handles (9") and a compound leverage of 18-to-1, the cutter allows for tightly spaced cuts of as little as 1/8-inch to assure rod lengths for the very lowest V.S.W.R.

The replaceable blades on the cutter are of the toughest precision hardened Swedish tool steel that will last for many cuttings.

Contact Larsen Electronics, Inc., P.O. Box 1686, Vancouver, Wash. 98663. Circle INFO/CARD 110. □

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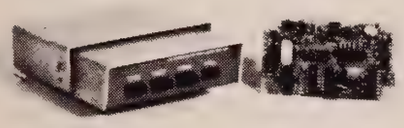

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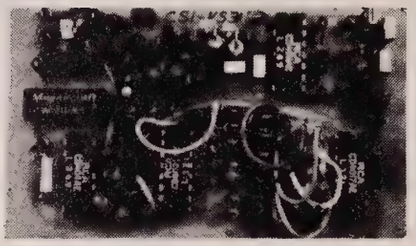

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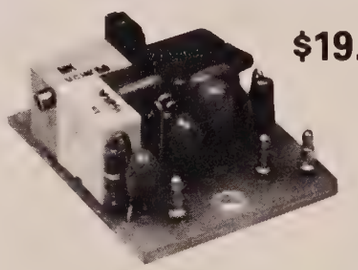

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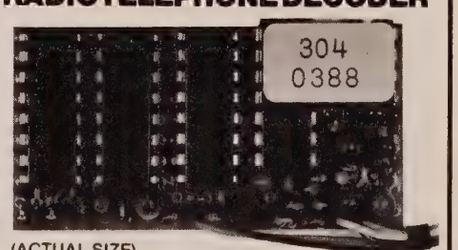

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Literature

Rental Catalog: Leasametric

Leasametric, Division of Metric Resources Corp., Burlingame, California, has published its new 1977/78 Instrument Databook & Rental Catalog covering the rental, lease, and sale of telecommunications and general purpose electronic test equipment.

The free 168-page catalog lists complete specifications/descriptions, monthly rental rates, and used-price ranges for thousands of instruments available for rent, lease, or sale. Virtually every leading test equipment manufacturer is represented.

Contact Leasametric at 822 Airport Blvd., Burlingame, Calif. 94010. INFO/CARD 111.

GSA Catalog: Standard Communications

Standard Communications Corp. of Carson, California, announces the availability of a GSA catalog covering its two-way radio equipment and accessories for distribution to federal government accounts.

The material available includes specifications, prices and ordering information.

Contract administration source is Maximum Security Systems Inc., 11512 Schuylkill Road, P.O. Box 2327, Rockville, Md. 20852. INFO/CARD 112.

Telecom Women Study: Telecommunications Marketing

A second more intensive research study concerning the role and effectiveness of women in the telecommunications industry is now being undertaken by Telecommunications Marketing Corp. in order to corroborate the findings of a recent survey.

Santiago said that the final success of the study is proportionate to the number of women who participate in it. He emphasized the need for greater participation by telecom women.

Copies of the questionnaire and related material will be sent free to any woman wanting to participate in the study. For further information call (212) 682-0774 or write Telecommunications Marketing, 565 Fifth Ave., Suite 820, New York, N.Y. 10017. INFO/CARD 113. □

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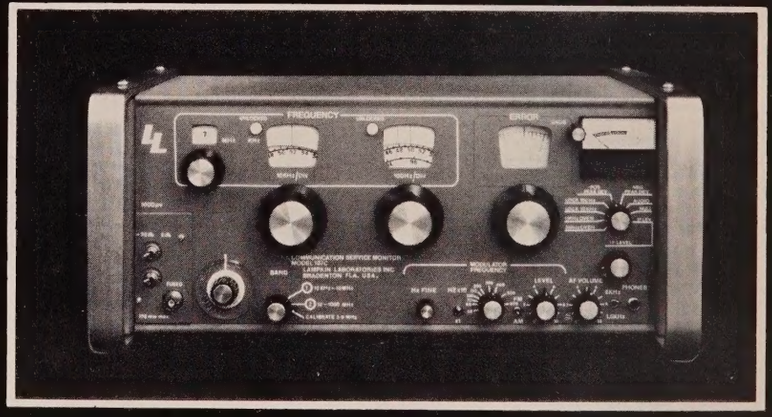

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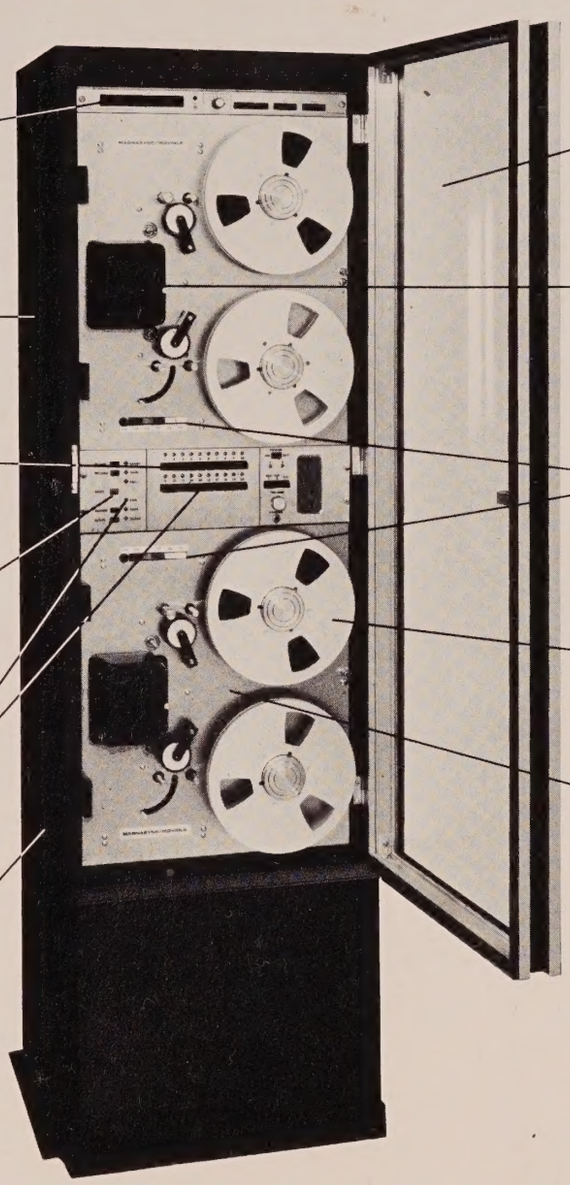

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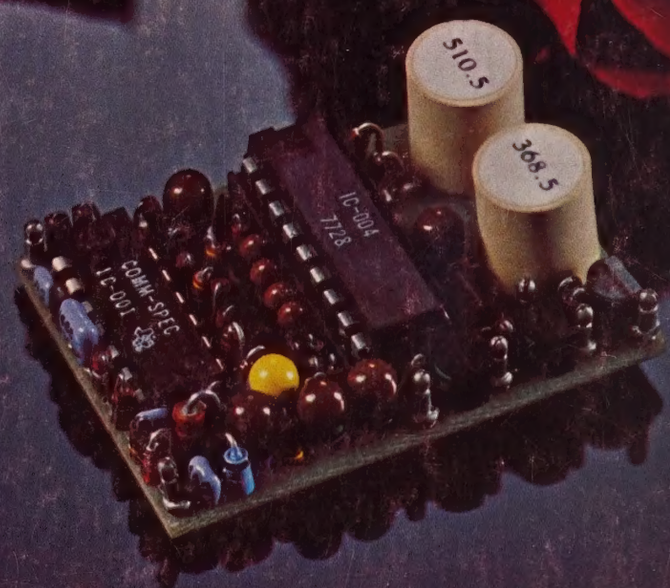

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